U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-298 191

# Coal and the Environment Abstract Series Bibliography on Mined-Land Reclamation

**Bituminous Coal Research, Inc, Monroeville, PA**

Prepared for

**Industrial Environmental Research Lab -Cincinnati, OH**

Apr 79

**DI**

United States
Department of the
Interior

Office of Surface Mining
Technical Services & Research
Washington DC 20240

PB 298191

**EPA**

United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Cincinnati OH 45268

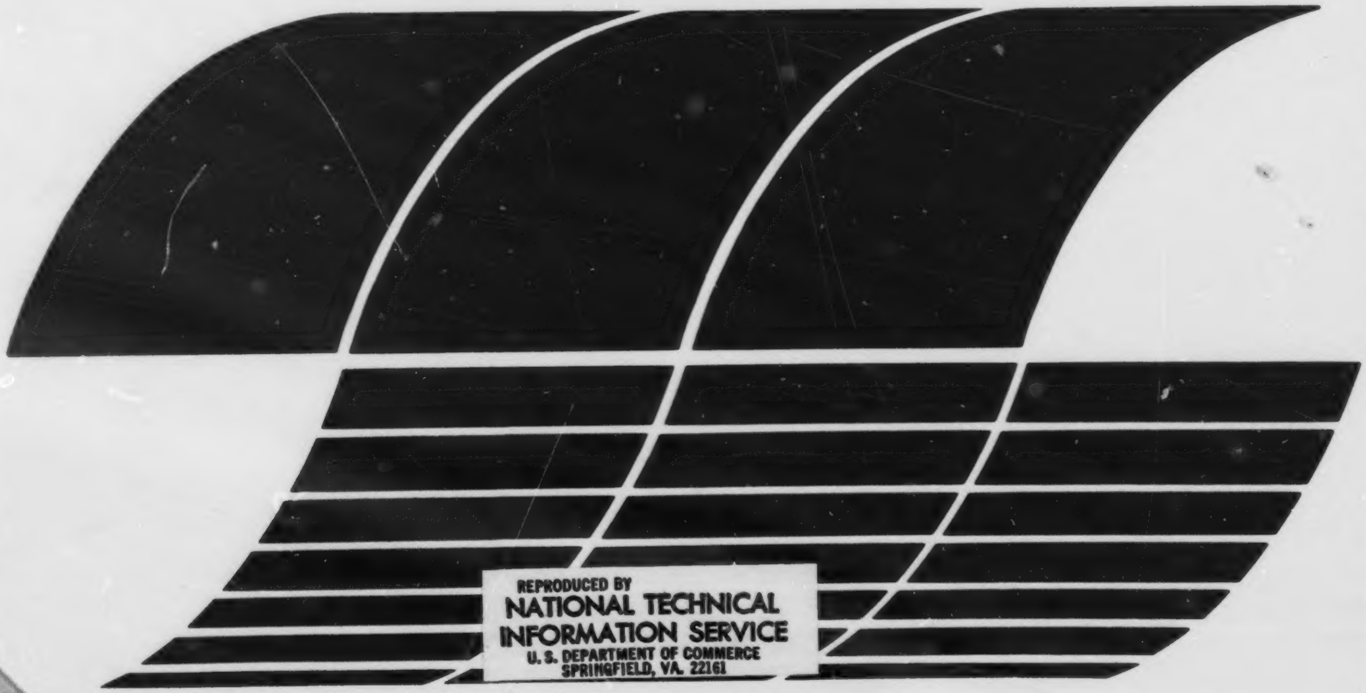
EPA-600/7-79-102
April 1979

Research and Development

# Coal and the Environment Abstract Series

## Bibliography on Mined-Land Reclamation

## Interagency Energy/Environment R&D Program Report



REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

## RESEARCH REPORTING SERIES

Research reports of the Office of Research and Development, U.S. Environmental Protection Agency, have been grouped into nine series. These nine broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The nine series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies
6. Scientific and Technical Assessment Reports (STAR)
7. Interagency Energy-Environment Research and Development
8. "Special" Reports
9. Miscellaneous Reports

This report has been assigned to the INTERAGENCY ENERGY-ENVIRONMENT RESEARCH AND DEVELOPMENT series. Reports in this series result from the effort funded under the 17-agency Federal Energy/Environment Research and Development Program. These studies relate to EPA's mission to protect the public health and welfare from adverse effects of pollutants associated with energy systems. The goal of the Program is to assure the rapid development of domestic energy supplies in an environmentally-compatible manner by providing the necessary environmental data and control technology. Investigations include analyses of the transport of energy-related pollutants and their health and ecological effects; assessments of, and development of, control technologies for energy systems; and integrated assessments of a wide range of energy-related environmental issues.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

## TECHNICAL REPORT DATA
*(Please read Instructions on the reverse before completing)*

1. REPORT NO.
EPA-600/7-79-102

2.

3. RECIPIENT'S ACCESSION NO.
PB298191

4. TITLE AND SUBTITLE
Coal and the Environment Abstract Series
Bibliography on Mined-Land Reclamation

5. REPORT DATE
April 1979 issuing date

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
V. E. Gleason

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Bituminous Coal Research, Inc.
Monroeville, Pennsylvania 15146

10. PROGRAM ELEMENT NO.
1NE623

11. CONTRACT/GRANT NO.
R-805336

12. SPONSORING AGENCY NAME AND ADDRESS
Industrial Environmental Research Laboratory
Office of Research and Development
U. S. Environmental Protection Agency
Cincinnati, Ohio 45268

13. TYPE OF REPORT AND PERIOD COVERED
Task Final

14. SPONSORING AGENCY CODE
EPA/600/12

15. SUPPLEMENTARY NOTES
Project also funded by Office of Surface Mining, Department of the Interior.

16. ABSTRACT

This volume is the third to appear in the "Coal and the Environment Abstract Series" and is a new edition of "Reclamation of Coal Mined-Land: A Bibliography with Abstracts." The other volumes in the series are "Mine Drainage Bibliography 1910-1976" and "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants." The three Bibliographies in the "Coal and Environment Abstract Series" are intended to complement one another. While each covers one particular subject area, inevitably some documents listed in one also are relevant to one of the other Bibliographies. In addition to the abstracts, this volume includes an Author Index and a General Index.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|---|
| Bibliography | Coal | | 02A |
| Mining | | | 02D |
| Agronomy | | | 06M |
| Soils | | | 08G |
| Erosion | | | 08I |
| Reclamation | | | |
| Spoil | | | |

18. DISTRIBUTION STATEMENT
Release to the public

19. SECURITY CLASS *(This Report)*
Unclassified

20. SECURITY CLASS *(This page)*
Unclassified

21. NO. OF PAGES
383

22. PRICE
A17-A01

EPA Form 2220-1 (9-73)

☆ U. S. GOVERNMENT PRINTING OFFICE: 1979-657-060/1668 Region No. 5-II

EPA-600/7-79-102
April 1979

# Coal and the Environment
# Abstract Series

# BIBLIOGRAPHY ON MINED-LAND RECLAMATION

Compiled by

V. E. Gleason
Bituminous Coal Research, Inc.
Monroeville, Pennsylvania 15146

Grant Number R805336-01

Project Officer

Ronald D. Hill
Resource Extraction and Handling Division
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

Co-sponsored by
Office of Surface Mining Reclamation and Enforcement
U. S. Department of the Interior
Washington, D.C. 20240

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U. S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

ia

# DISCLAIMER

This report has been reviewed by the Industrial Environmental Research Laboratory, U. S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U. S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

# FOREWORD

When energy and material resources are extracted, processed, converted and used, the related pollutional impacts on our environment and even our health often require that new and increasingly more efficient pollution control methods are used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet those needs both efficiently and economically.

This publication is the third of the "Coal and the Environment Abstract Series." It provides the researcher, scientist, mine executives, and regulators with a timely bibliography. Not only will it provide the research community with a means of readily accessing the literature, but it should provide those persons implementing enviornmental controls at surface mines with a handy reference to solving their problems. Additional bibliographies are planned for this series.

For further information contact the Resource Extraction and Handling Division, IERL-Cincinnati.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

# PREFACE

Coal is our most plentiful source of energy, and its use is essential to the well-being of the nation. As coal continues to be produced and as mines are opened in areas where mining has not existed previously, opportunities for the occurrence of environmental degradation will increase. However, such degradation need not occur if the existing and evolving pollution control technology is well known and properly applied.

Numerous public and private efforts have contributed to the knowledge concerning coal's environmental problems and to their control. This knowledge is well documented, and the U.S. Environmental Protection Agency has been actively involved in compiling and disseminating it. One facet of this activity has been the co-sponsorship of an environmental library at Bituminous Coal Research, Inc., for use by the public as well as the coal industry, and the publication of Bibliographies of abstracts based on the collections within the library.

This volume is the third to appear in the "Coal and the Environment Abstract Series" and is a new edition of "Reclamation of Coal Mined-Land: A Bibliography with Abstracts" which was compiled by BCR and published by the National Coal Association in 1975. Preparation of this new edition was co-sponsored by EPA, Department of Interior's Office of Surface Mining and Enforcement, and BCR. The other volumes in the series are "Mine Drainage Bibliography 1910-1976" and "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants." The Mine Drainage Bibliography was prepared in 1976 by BCR with co-sponsorship of the Pennsylvania Department of Environmental Resources and EPA. Copies of this Bibliography can be obtained from BCR or from NTIS as PB-265 041/4BE. The Refuse Disposal Bibliography, prepared in 1978 by BCR with support from EPA, can be obtained from BCR or from EPA's Resource Extraction and Handling Division, Cincinnati, Ohio.

The three Bibliographies in the "Coal and Environment Abstract Series" are intended to complement one another. While each covers one particular subject area, inevitably some documents listed in one also are relevant to one of the other Bibliographies. For example, the Reclamation Bibliography includes information on the effects of mining and reclamation on hydrology and, to some extent, on water quality. However, much of the information on changes in water quality resulting from surface mining and reclamation has been listed in the Mine Drainage Bibliography. Another example of overlap is in the assignment of documents concerned with overburden or spoil. In American usage, these terms are synonymous but in British usage, the term "spoil" includes both overburden and refuse from coal cleaning plants. Documents on "spoils" have been separated into those relating to refuse and to overburden and put in the proper Bibliography. Since a number of British documents give information on both kinds of spoils, the reader should probably scan both the Reclamation Abstracts and the Refuse Disposal Abstracts. Finally, many documents include material on each of the subject areas covered by the Bibliographies. If one environmental area has been emphasized more than the other two, the document is listed only in that major area, but it is indexed in that Bibliography to show that it also contains information relating to the other subjects. If there are major emphases on more than one area, the document is listed in each of the Bibliographies to which it is relevant.

In addition to the abstracts, this volume includes an Author Index and a General Index beginning on page 279. These indexes are described in the section, "Format and Use of the Bibliography." In the Appendixes, are lists of the publications most recently acquired for the "Coal and the Environment Abstract Series." Appendix I continues the update of "Mine Drainage Bibliography 1910-1976" which was begun in the previous volume of this Series. Appendix II gives an update for "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants."

Much of the literature listed in the "Coal and the Environment Abstract Series" is available from large libraries, government agencies issuing particular reports, or from the authors. Complete citations have been given so that the reader can obtain material from these sources. Items with NTIS numbers at the end of the citation may be purchased from U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161. For those who have difficulty in obtaining material from these sources, arrangements can be made to use the library at BCR on weekdays between 8:00 a.m. and 4:30 p.m. Limited interlibrary loan service and photocopies of non-copyright material for a nominal fee are also available. Please direct requests to Librarian, Bituminous Coal Research, Inc., 350 Hochberg Road, Monroeville, Pennsylvania 15146.

Searching for and acquiring information on environmental aspects of coal mining and coal cleaning is a continuing effort. Although coverage of the early literature is essentially complete, some more recently published material may not have been included. Copies of any publications not listed here, as well as of new publications, should be sent to BCR for inclusion in future issues of the Bibliographies. Any other suggestions, comments, or criticism of this publication are welcomed.

Additional copies of this publication may be obtained from:

Bituminous Coal Research, Inc.
350 Hochberg Road
Monroeville, Pennsylvania 15146

U.S. Environmental Protection Agency
Industrial Environmental Research Laboratory
Resource Extraction and Handling Division
Cincinnati, Ohio 45268

Office of Surface Mining Reclamation and Enforcement
U.S. Department of the Interior
18th & C Streets, N.W.
Washington, D.C. 20240

# ABSTRACT

This volume is the third to appear in the "Coal and the Environment Abstract Series" and is a new edition of "Reclamation of Coal Mined-Land: A Bibliography with Abstracts." The other volumes in the series are "Mine Drainage Bibliography 1910-1976" and "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants." The three Bibliographies in the "Coal and Environment Abstract Series" are intended to complement one another. While each covers one particular subject area, inevitably some documents listed in one also are relevant to one of the other Bibliographies. In addition to the abstracts, this volume includes an Author Index and a General Index.

This publication has been financed by Bituminous Coal Research, Inc., and by Federal funds from the U. S. Environmental Protection Agency and from the Office of Surface Mining Reclamation and Enforcement, USDI, under grant number R805336-01.

## CONTENTS

Page

Preface.......................................................... iv

Format and Use of Bibliography................................... viii

Abstracts, 1928 - 1978........................................... 1

Author Index..................................................... 279

General Index.................................................... 299

Appendix I, COAL AND THE ENVIRONMENT ABSTRACT SERIES:
MINE DRAINAGE BIBLIOGRAPHY (Alphabetical listing of
second update of 1976 Bibliography).............................. 354

Appendix II, COAL AND THE ENVIRONMENT ABSTRACT SERIES:
BIBLIOGRAPHY ON DISPOSAL OF REFUSE FROM COAL MINES AND
COAL CLEANING PLANTS (Alphabetical listing updating
1978 Bibliography)............................................... 362

# FORMAT AND USE OF THE BIBLIOGRAPHY

The abstracts are grouped according to the year of publication, with each section being headed by its chronological designation. Within each year there are two groups of abstracts, each arranged alphabetically by the first author, or, if no personal author, by title. The first group contains the abstracts which appeared in the 1975 edition, while the second group has been compiled from the material added to the BCR collection since the earlier edition was prepared. Each abstract is numbered sequentially within the year of publication and has its own unique number: for example, R74-109. The letter R indicates the general subject area of reclamation of lands disturbed by surface coal mining. The next two digits refer to the year of publication. The number to the right of the hyphen indicates the order in which that abstract is listed within the publication year. These unique numbers are used to reference the abstracts in the indexes. At the end of each abstract are either letters, numbers, or various letter-number combinations. These are related to the filing of material in the BCR Library, and will aid the BCR staff in answering questions on the availability of the material.

The Author Index includes the names of all persons who have been listed as authors or editors of any publication. When the organization is shown as the author, it is listed in the General Index. Names beginning with Mc or Mac have been included alphabetically, as spelled, and are not grouped together.

The General Index includes the following categories: names of industry, government, and academic organizations engaged in or sponsoring work related to mined-land reclamation; geographic features such as names of foreign countries and of states and regions of the United States; and subject area topics such as land use and vegetation on reclaimed mined land. Terminology is as specific as possible and at the same time is controlled to provide consistency.

Federal government agencies are listed by name and are not grouped together under United States. As an example, Appalachian Regional Commission appears in "A" listings and Old West Regional Commission appears in "O" listings. Both are identified as being part of the United States Government. Subordinate parts of government agencies also are used as main index entries, with cross references from the parent organization. Forest Service is a main entry and has a cross reference from "Agriculture, U.S. Department of." Northeastern Forest Experiment Station is one of the several Forest Service Experiment Stations used as main index entries with referral from the Forest Service.

State agencies are indexed using the name of the state as the initial word of the agency title. For example, Illinois Department of Mines and Minerals and Pennsylvania Department of Environmental Resources are used as main index entries.

In all categories, cross references and supplemental words and phrases are used liberally to facilitate information retrieval. All entries in the General Index are intermixed in strictly alphabetical order which follows the word-by-word method, with hyphenated words considered as one word.

The appendixes are updates of the two other Bibliographies described in the Preface and appear after the indexes. Publications are listed alphabetically by author or title in each category: coal mine drainage and disposal of coal refuse. No abstracts are included for these items, nor are they indexed. However, these abstracts will be included in the subsequent abstract bibliographies planned for each subject area.

## 1928

### R28-1 REVEGETATION OF ILLINOIS COAL STRIPPED LANDS

Croxton, W. C. (Univ. Ill.), Ecology 11 (2), 155-175 (1928). Studies of strip mined areas in Vermilion County showed that water, as well as soil acidity, is a critical factor in revegetation. Impermeable acid ridges were barren while other areas of similar acidity but with adequate soil moisture supported growth. Analyses of highly acid base soils showed the presence of nitrogen, phosphorus and potassium, indicating that acidity, not lack of fertility, prevented plant growth. Observation of the natural succession of pioneer plants showed that succession was influenced by acidity of the soil and that vegetation was prevented for long periods on the most acid soils. R348

## 1940

### R40-1 THE STORY OF OPEN CUT MINING IN INDIANA

Indiana Coal Producers Association, 1940. (30 pp.) This illustrated booklet gives a comprehensive history of strip mining and reclamation in Indiana. History, preparation, water conservation, and future use of mined lands are all discussed in detail. Considerable space is devoted to recreational land uses. Overall agricultural benefits and the community value of the industry are outlined. R208

## 1941

### R41-1 REVEGETATION OF COAL STRIPPED LAND NEAR HENRYETTA, OKLAHOMA

Maloney, M. M., Proceed. Okla. Acad. Sci. 1941 22, 123-129 (1941). This ecological study was made of a former stripped area which was allowed to revegetate naturally. When this area was stripped, the topsoil was replaced and the deep subsoil was mixed and placed on the surface. This material was high in iron sulfide and a high acid environment resulted. Vegetation is mainly trees and shrubs, those with an extensive root system, acid tolerant, and can grow with a minimum of nitrogen. In order for calciferous plants to grow in this area it is estimated that at least four to five tons/acre of lime would be needed. R260

### R41-2 STRIP RECLAMATION IN EASTERN OHIO

Coal Age 46 (10), 114-6 (1941). The Ohio Reclamation Committee undertook to reclaim 43 percent of the total stripped land to provide fishing, hunting, or other recreational facilities. The work was in charge of a full time director. Several pictures show some of the results obtained. All costs for trees, planting, labor, etc. are paid for by the Committee. About 200,000 trees were planted in 1941. Conifers fit best into the program by returning a cash yield in 15 years or less. Activity of the Committee was supplemented by other County Agricultural and Sportsmen's Associations. R318

## 1942

### R42-1 TREE PLANTING GUIDE

Sawyer, L. E., Indiana Coal Producers Assoc., Dept. Forestry and Reclamation (Undated. 7 pp.) The guide was prepared for supervisory personnel of mines who are responsible for plantings to be made according to Indiana Legislation of 1941, and who might not be familiar with proper care and planting of nursery stock. R99

### R42-2 PLANTING SPOIL BANKS AND DITCHES

Culbertson, R. E. and May, R. M., Soil Conservation 7 (10), 260 (Apr. 1942). Plants that may be seeded directly on spoil banks are identified. R956

### R42-3 COAL-STRIPPED LAND AS A MAMMAL HABITAT WITH SPECIAL REFERENCE TO FUR ANIMALS

Yeager, L. E., American Midland Naturalist 27 (3), 613-635 (May 1942). A survey of mammals on strip-mined land was carried out from 1938 to 1941. Most of the investigations were in Vermilion County, Illinois. Of the nine fur bearers discussed, the most commonly found was muskrat, particularly where drainage ditches and strip-mine ponds made water plentiful. The occurrence of 17 nonfur-bearing mammals was also noted. The development of vegetative cover and forests on strip-mined land improved it as a habitat for mammals. R964

## 1943

### R43-1 TWO THOUSAND ACRES OF NEW FORESTS PLANTED: REFORESTATION OF STRIP-MINE LAND TO PROVIDE FUTURE TIMBER SUPPLY

Outdoor Indiana 10 (10), 11, 13 (Nov. 1943). The tree planting program carried out in response to the requirements of the 1941 Indiana strip mine legislation is described. Most of the seedlings used were pines. R912

## 1944

### R44-1 HANDLING WATER TO SAVE TIME AND MONEY AT STRIP MINES

Richart, F. W., Coal Age 49 (1), 59-62 (1944). Necessary considerations of water handling in a strip mining area include a proper box cut design, drainage ditches, pumping stations, haulageways and a preparation plant. A permanent pumping system should include a frostproof or heated building. Drainage ditches should be parallel to the main pit to make diversion easier. Outdoor equipment and controls should be weatherproof and portable pumps are a requirement. Care must be practiced to make sure these pumps are drained in winter to prevent damage from freezing. R319

R44-2 FOREST PLANTING ON STRIP-MINED COAL LANDS WITH SPECIAL REFERENCE TO OHIO

Chapman, A. G., U.S. Department of Agriculture, Central States Forest Experiment Station, Dec. 26, 1944. 25 pp. The author suggests that spoils be classified in three major groups on the basis of geologic materials in the overburden: Group 1 spoils of glacial till, sandstones, and acid silt shales; Group 2 spoils of sandstones and acid silt shales; and Group 3 spoils of sandstones, marly shales and limestones. Within each group of spoils, other characteristics as proportion of rock present, resistance of rocks to weathering, and composition of rocks, are discussed in relation to time elapsing before being plantable and to choice of species for planting. In many banks a weathering and settling period is essential for the development of a "soil" sufficiently compact to retain enough moisture for tree survival during the dry seasons and to allow time for the leaching of elements toxic to tree seedlings. A tree-planting program, carried on for several years on Group 2 spoils in the Kehota Area of Perry County, Ohio, showed that black locust was superior to pines or hardwoods. Hardwood stands could be established by planting with or under black locust or just after black locust was harvested. (Adapted from author's Summary) CE310

## 1945

R45-1 THE RECLAMATION OF THE STRIP-MINED COAL LANDS OF WEST VIRGINIA WITH FORAGE SPECIES

Tyner, E. H. and Smith, R. M. (W. Va. Agr. Expt. Sta.), Soil Sci. Soc. Amerc. Proc. 10, 429-436 (1945). Spoil is classified into three types according to the pH of the spoil surface. Experimental plantings of grasses and legumes showed that even very acid spoil will support vegetation after liming and with addition of nitrogen and phosphorus. Mulching, adequate seed bed preparation, and prevention of cutting or grazing also aid in establishing vegetation. R425

## 1946

R46-1 SPOIL RECLAMATION - ASSURES GOOD INCOME WITHOUT LEVELING

Coal Age 51 (7), 91-4 (1946). Tree growth was found to be better on unleveled spoil and topping spoil with soft earth was found to be very advantageous. Fruit trees were under experimentation but not used generally. The establishment of separate farm departments by coal companies was being considered at this time. A number of Illinois operators were using airplane seeding. Hogs were to be tried at this point and were expected to do well. Leveling at this time was considered uneconomical. Lakes proved successful in Ohio, Illinois and Indiana. R320

R46-2 INDIANA STRIP-MINE PLANTINGS

Sawyer, L. E. (Indiana Coal Producers Association), J. Forestry 44, 19-21

R46-2 (continued)

(1946). The author reviews the tree planting program in Indiana and comments on the success or failure of various species. R890

## 1947

### R47-1 REFORESTATION - SOLVES STRIP-SPOIL PROBLEM IN INDIANA

Sappenfield, V., Coal Age, 52 (4), 112-3 (1947). The Indiana Coal Producers Association in the previous year had planted 118 acres. Some areas became popular recreation places and several lakes have become good fishing areas. In 1938 the association hired a full time forester. Mr. Sawyer succeeded Mr. Hyatt in 1944. The land in Indiana was generally more valuable after stripping than before. Selected plots have been planted to learn the species most suitable for the area. A program to develop grazing areas was started using sweet clover, timothy, bluegrass and other grass mixtures. R321

### R47-2 OPEN CUT MINING IN INDIANA

Sawyer, L. E., *et al.*, Ind. Coal Producers Assoc. (undated). (16 pp.) Several short articles about strip mining and about tree growing and recreation on strip mined land are included in this 1940's publication. R406

### R47-3 UNLEVELED SPOIL BRINGS GOOD RETURN AS FARMING PROJECT

Edwards, J. H., Coal Age 52 (2), 92-97 (1947). The superintendent of Truax-Traer Coal Company's Red Ember mine in Fulton County, Illinois, began in 1936 to experiment with small plots of mined land. By 1941 he had purchased 600 acres from the coal company and developed the tract into farm land which supported a herd of beef cattle. Lakes and ponds formed on the reclaimed land serve as a source of drinking water for the cattle, and are used for fishing, hunting, and trapping, and as irrigation water for a gladioli grower. Vegetation on the seeded spoil banks was noticeably more abundant than vegetation on adjacent unmined land. Jour

### R47-4 AN ECOLOGICAL AND ECONOMIC STUDY OF COAL STRIPPED LAND IN EASTERN OHIO

Riley, C. V., M.S. Thesis, Ohio State University, 1947. 205 pp. The history and extent of surface mining, particularly in Ohio, was reviewed and served as the background of this survey of a surface-mined area of more than 1000 acres in Wayne Township, Tuscarawas Cty., Ohio. The detailed characterization of the area included spoil classification. The field study was carried out to determine the extent of volunteer revegetation, the success of planned revegetation, the use of the area as wildlife habitat, and economic return of surface-mined land as compared to agricultural, forest, and abandoned land. It

R47-4 (continued)

was suggested that management of surface-mined land for wildlife and tree production might have the most value. Ohio State Univ. Lib.

## 1948

### R48-1 RESEARCH ON REFORESTATION OF SPOIL BANKS IN PENNSYLVANIA

Bramble, W. C., Chisman, H. H., and Deitschman, G. H., The Pa. State Forest School, Res. Paper No. 10 (Feb. 25, 1948). 6 pp. This paper describes a reforestation research project on spoil banks conducted in 1946. Nineteen tree species were used in the test areas in Jefferson, Clearfield, Clarion and Fayette Counties, and also Westmoreland, Allegheny, Washington and Butler and Mercer Counties. Each species plot contained 100 trees. A table shows the early survival for plantings on 12 spoil banks. Preliminary results indicate differences in the suitability of various species for banks of different acidities. R277

### R48-2 MAN-MADE FORESTS IN INDIANA

Fox, S. D., Indiana Coal Producers Assoc., Div. Forestry and Reclamation (undated). (32 pp.) The history of Indiana strip mining from early days onward shows reclamation efforts in forestation. R52

### R48-3 RECLAMATION OF STRIP-MINED AREAS IN WEST VIRGINIA

Tyner, E. H., Smith, R. M., and Galpin, S. L. (W. Va. Agr. Expt. Sta.), J. Soc. Agronomy 40, 313-23 (1948). This paper reports results of revegetation obtained by West Virginia Agricultural Experiment Station on the canyon plots in Northern West Virginia. The spoil materials were classified as A, B and C. A separate section is devoted to each type of spoil and details of the procedure used in each case are outlined. Since these spoils are acid, lime was used in each case. Pictures are included of the canyon area. Delaying reclamation three years produced better ground cover than a delay of one year. Recommendations are made for each type of spoil material. Root activity has much to do with the survival of plants since some penetrate further in searcl of water. R343

### R48-4 THE ECONOMICS OF STRIP COAL MINING WITH SPECIAL REFERENCE TO KNOX AND FULTON COUNTIES, ILLINOIS

Graham, H. D., University of Illinois, Bureau of Economic and Business Research, Bulletin No. 66 (1948). 77 pp. This in depth discussion considers reclamation and uses of mined land. Forest crops harvested from trees plante up to 17 years previously included posts, beams, mine props, and Christmas trees; pasture land is suggested as another use; and fishing lakes from strip pits and other recreational facilities are noted. R902

### R48-5 STRIP COAL MINING AREAS OF SOUTHWESTERN INDIANA: THEIR DISTRIBUTION, GROWTH AND RESTORATION

Loring, R. D., M.A. Thesis, Indiana University, 1948. 94 pp. This survey of surface mining and reclamation in Indiana includes discussions of the great increase in surface mining in the three decades prior to the study; the history of attempts to legislate reclamation in Indiana; and the efforts of coal producers in planting spoil banks. The 1941 Reclamation Act and compliance with its provisions are reviewed. Although some areas were seeded to grasses, trees have mainly been used in revegetation, and these forestation efforts are summarized. Other uses of mined land are also discussed. Ind. Univ. Lib.

### R48-6 REVEGETATION OF THE STRIP COAL MINES IN INDIANA

Winchell, J. H., Outdoor Indiana 15, 10-13 (Jan. 1948). The author describes the establishment of forests on mined land by Indiana coal companies. R908

## 1949

### R49-1 PROGRESS IN STRIPPED LAND REGENERATION RESEARCH

Chapman, A. G., Am. Mining Congr., Cleveland, Ohio, May 11, 1949. 11 pp. Information from a 1948 report shows extent and concentration of strip mining in the Central States Region. A tentative planting guide which was developed according to acidity and texture classes of spoil materials is discussed. R55

### R49-2 AGRONOMIC RESEARCH ON THE STRIP BANKS IN ILLINOIS

Grandt, A. F., National Coal Assoc., Proc. 1949 Convention, pp 153-161. The author reviews studies at the University of Illinois on the soil characteristics, pasture establishment, chemical analysis of forage material and soil analysis. Each of these subjects is discussed in some detail and a section is devoted to species adopted and development of livestock. Strip mine soil material in Illinois in general is very readily adapted to pasture land. With the exception of nitrogen, the essential plant nutrient level is high. R278

### R49-3 REHABILITATION OF LANDS STRIPPED FOR COAL IN OHIO

Limstrom, G. A. and Merz, R. W., Ohio Reclamation Assoc., Central States Forest Expt. Sta. Tech. Paper No. 113, Dec. 1949. 41 pp. This booklet describes the character and extent of strip mined lands in Ohio, including age, classes of spoils, diversity of site conditions, and rehabilitation problems. A section of the publication describes planting and seeding experiments, and effects of acidity, slope, and aspect on survival and growth. Considerable tabulated data are included with a list of specific planting recommendations and the performance data on each species of tree in the test project. An appendix shows coal seams involved and description and chemical analyses of the cover on each seam. R57, 40-56

R49-4 REVEGETATION OF STRIP COAL SPOIL BANKS OF INDIANA

Stiver, E. N., Indiana Coal Prod. Assoc., Div. Forestry and Reclamation, Feb. 1949. 16 pp. This excerpt from the author's doctoral thesis reviews the problem of revegetating strip-mined lands and discusses results of his research. R56

R49-5 REVEGETATION OF STRIP COAL SPOIL BANKS OF INDIANA

Stiver, E. N., Ph.D. Thesis, Purdue Univ., 1949. 94 pp. To study the problem of classifying spoil banks and establishing vegetation upon them, the field of research has been divided into four parts: one, a study of the topography and its rate of change; two, a study of the physical and chemical properties of the spoil; three, a study of plant reactions upon spoil material; and four, general observations which include a survey of volunteer plants on the spoil banks. (Adapted from text) Purdue Univ. Lib.

R49-6 STRIP MINING: WASTE OR CONSERVATION?

Bramble, W. C., American Forests, pp 24-25, 42-43, June 1949. Methods and economics of surface mining and reclamation and the requirements of the 1945 Pennsylvania legislation regulating reclamation are discussed. R940

R49-7 COAL PRODUCERS GIVE ADDITIONAL LAND FOR FOREST

Outdoor Indiana 16, 2 (Oct. 1949). Lands, including strip-mined areas, donated to the Indiana State Forest system have been planted with seedlings by the members of the Indiana Coal Producers Association. R909

R49-8 OUR LAND IS GREEN AGAIN!

Outdoor Indiana 16 (4), 6-7, 19 (Apr. 1949). The reforestation of surface-mined lands in Indiana is described. R915

R49-9 THE USE OF SURFACE MINED LAND

Sawyer, L. E. (Indiana Coal Producers Association), J. Soil and Water Conservation 4, 161-165, 170 (Oct. 1949). Trees planted in the reclamation program of the Indiana Coal Producers Association, dating from the 1920's, produced various kinds of valuable forest products by 1949. Experience with evergreen and deciduous species is reviewed. The author also discusses the controversy over whether or not to grade the ridges of overburden left from mining. He points out that the superior growth of trees on ungraded spoil shows the detrimental effects of compaction of soil by grading. Studies by the Central States Forest Experiment Station are cited to show the greater infiltration of rainfall on ungraded land with consequently less runoff and erosion. R878

## 1950

R50-1 STRIPPING BUILDS BETTER LAND

Cheasley, T. C., Reprinted from Coal Age, March 1950. Various reclamation projects in several states are illustrated. A list of national reclamation organizations is included as well as a list of organizations supported directly by the strip coal operators. R84

R50-2 A NEW LAND

United Electric Coal Companies - Fidelity Mine, Duquoin, Ill. Undated (issued between 1948-1950). 16 pp. This booklet describes the operations of the Fidelity mine of United Electric Coal Co. which produces 7000 tpd of strip mine coal. This company has had for many years a reclamation program whereby it converts its mined land to farm area for grazing, agriculture and reforestation. Much of their land is turned into orchards and vineyards. Many of the lakes have been stocked and the surrounding areas converted for recreational purposes. The fact that at the time of publication one sixth of Illinois or 1 million acres lay idle, incapable of producing profitable crops is contrasted to 50,000 acres being strip mined productively and returned to use. R254

R50-3 INITIAL SURVIVAL OF PLANTED HARDWOODS ON STRIP MINE SPOIL BANKS OF INDIANA

Arnott, D., Jr., M.S. Thesis, Purdue University, 1950. 61 pp. Ten hardwood species were planted in twelve sample plots of approximately five acres each in the spring of 1949. Survival counts of marked sample trees were made in the spring and fall of 1949 and in the spring of 1950. In acid spoil, black locust had the best survival. In plots where spoil pH was above 6.0, black locust, green ash, silver maple, and sycamore showed better survival than the other species used. Tulip poplar and Ailanthus showed the lowest rate of initial survival. (Adapted from author's abstract) R947

## 1951

R51-1 RECLAIMING ILLINOIS STRIP COAL LANDS BY FOREST PLANTING

Limstrom, G. A. and Deitschman, G. H., Univ. Ill., Agr. Expt. Sta., Bull. 547, (Nov. 1951). 50 pp. Character and extent of strip coal lands; site conditions in five strip mining districts; forest planting possibilities, experiments, and recommendations; and a review of the literature are included in this review of reclamation in Illinois. Classifications of strip mined lands and chemical analyses of strata over coal seams are tabulated in the appendix. R62

R51-2 STRIP-MINED LANDS OF THE WESTERN INTERIOR COAL PROVINCE

Rogers, N. F., Univ. Mo., Agr. Expt. Sta., Res. Bull. 475 (1951). 55 pp. (Contribution of Central States Forest Expt. Sta., U.S. Dept. Agr.). In this area,

R51-2 (continued)

consisting of Arkansas, Iowa, Kansas, Missouri, and Oklahoma, about 65,000 acres of land had been strip mined by 1951. The report gives the history of strip mining, the coal seams involved, overburden analyses, character of the strip mined land, uses of reclaimed land, and an inventory of vegetation on strip mined land. R628

R51-3 MORE STRIP PITS FOR FISHIN'!

Outdoor Indiana 18 (12), 18-19 (Dec. 1951). Amendments to the Act regulating surface mining for coal in Indiana are described. One of the requirements is to construct earth dams to close the final cut where it would be practical to construct a lake. R916

R51-4 FISH POPULATION OF A MINING PIT LAKE, MARION COUNTY, IOWA

Ruhr, C. E., M.S. Thesis, Iowa State College, 1951. 77 pp. Ike Lake near Knoxville, Marion County, Iowa, was formed from a strip pit in an area mined in 1932 and 1933, and was investigated for this study in the summer of 1950. Inflow was only from drainage from the 23.6 acre watershed, some of which was under cultivation. Water had a pH range of 6.5 to 7.8 and was classified as soft. Cattail and narrow leafed pondweed were the only aquatic vegetation, with pondweed being dense in water less than 6 feet deep. From previous stockings, fish population was made up of northern black bullhead, largemouth black bass, green sunfish, bluegill, white crappie, and bluegill-green sunfish hybrids. The fish population was sampled and examined for food intake, parasitism, and age and growth. Fish appear to be well established although elimination of white crappie is recommended. Other recommendations for fishery management include fertilization of the lake to improve growing conditions for the fish and encouraging more fishing to relieve pressure of too large a fish population. Iowa State Univ. Lib.

## 1952

R52-1 REFORESTATION OF STRIP-MINED BITUMINOUS COAL LAND IN PENNSYLVANIA

Bramble, W. C., J. Forestry 50, 308-314 (1952). This paper describes all the factors involved in a reforestation program, including soil acidity, soil content, wind exposure, soil temperature, slope and parent material. The information also includes data from a survey of spoil bank plantings of many trees on different classes of spoils. Survival percentages are given and the various trees involved in each class of spoil material are listed. Fall planting was successful in certain areas where winter resistant trees were selected. Direct seeding tests were generally unsuccessful. R264

R52-2 STRIP-MINE FARMING

Meadowlark Farms, Inc., August 1952. 22 pp. The farm programs of Ayrshire Collieries Corp., now Amax Coal Co., have been carried out on land which has been

R52-2 (continued)

strip mined. There are many pictures of the hogs, cattle, and sheep raised successfully as well as of grain crops and trees. R53

R52-3 THE GROWTH OF STRIP COAL MINING IN INDIANA

Loring, R. D. (DePauw University), Indiana Academy of Science Proceedings 61, 184-186 (1952). This paper traces the growth of surface mining in Indiana from 1914 through 1949. R877

R52-4 AN EVALUATION OF RECLAIMED COAL STRIP MINED LANDS AS WILDLIFE HABITAT

Riley, C. V., Ph. D. Thesis, Ohio State University, 1952. 257 pp. Surface-mined lands and surface-mine ponds in Ohio, Illinois, and Indiana were surveyed intensively from April 1947 through July 1951. The plant, animal, bird, and fish species found are listed and are also evaluated "in terms of the type and value of wildlife habitat produced by a particular plant species or group of species and the wildlife inhabiting each planting." Cover observed on surface-mined areas included both volunteer and planted vegetation ranging from seedings to vegetation established more than thirty years. Classification of the spoil surfaces by pH indicated that four percent or less of the spoils were so toxic that they would not support normal growth. A laboratory study of various overburden materials to determine their effect on the pH of water showed that iron sulfides were responsible for acidity associated with surface-mined areas. Included in suggestions for managing these areas for wildlife are 1. to cover toxic material with at least three feet of unreactive material, and 2. to plant suitable legumes and shrubs among the forest plantings and pasture seedings. Ohio State Univ. Lib.

## 1953

R53-1 REVEGETATION OF STRIP-MINED AREAS IN OKLAHOMA

Garner, R. V. (Oklahoma A. & M. College), Proc. Okla. Acad. Sci., 34, 208-9 (1953). This article explains the fact that Oklahoma has no reclamation law like many other states and for this reason, the Forestry Department, State Universities and the Soil Conservation Service have combined to try some experiments. The project established the fact that the spoil areas had adequate moisture but were deficient in nutrients. Most Oklahoma spoil areas are suitable for forests. Black locust and evergreens have been found to grow best, especially for Christmas tree, fence post, mine prop and pulp wood production. Selective planting and thinning gives trees of highest quality. Near Tulsa, overburden areas are being used for industrial purposes as the most valuable use. R274

R53-2 STRIPMINE RECLAMATION RESEARCH IN OHIO

Knudsen, L. L. and Struthers, P. H. (Ohio Agr. Expt. Sta.), Ohio J. Sci. 53 (6), 351-55 (1953). This article traces the development of stripmine reclamation in Ohio resulting in the formation of the Ohio Reclamation Association and several similar organizations and describes the reclamation research program of the Ohio Agricultural Experiment Station. These two organizations now carry on continuous reclamation programs using trained foresters and horticulturists. Preliminary investigation has shown that high soil acidity is accompanied by relatively high solubility of elements such as iron, aluminum, manganese, copper, zinc, lead and nickel which though toxic at high concentrations are essential for plant growth in trace amounts. R344

## 1954

R54-1 FOREST PLANTING ON STRIP-MINED LAND IN KANSAS, MISSOURI AND OKLAHOMA

Clark, F. B., U.S. Dept. Agr., Central States Forest Expt. Sta. Tech. Paper No. 141 (March 1954). 33 pp. Survival and early growth rate of species of trees planted at various locations in the 3-state area have been obtained from two experiments. Data are tabulated in the appendix. (From author's summary) R54

R54-2 EFFICIENT STRIPPING WITH SMALLER EXCAVATING UNITS

Coal Age 59 (7), 63-5 (1954). In the strip mining operation of P & K Inc. at Port Allegany, McKean County, Pennsylvania, land reclamation is a continuous job where spoil banks are leveled and compacted by bulldozers. The company constantly patrols the operations, checking the pH of water pits. If it is not satisfactory, a lime slurry is added before it is released to area streams or pumped over spoil banks. Worked out cuts are backfilled with spoil to a depth of at least 4 feet above the original elevation of the coal. The remainder of the spoil is then bulldozed outward to provide a surface as level as possible for future planting. R299

R54-3 SUNNYHILL MAKES ITS MONEY DO A JOB

Flowers, A. E., Coal Age 59 (5), 84-91 (1954). The reclamation, as well as the mining methods, at the No. 8 Mine of Sunnyhill Coal Co., New Lexington, Ohio are described. Reclaimed land is planted to locust and hardwood trees which are expected to be harvested and sold for profit. Costs of reclamation are an average of $178 per acre with the company setting aside 5 cents per ton of coal mined for reclamation work. R298

R54-4 THE UTILIZATION OF RECLAIMED COAL STRIPLANDS FOR THE PRODUCTION OF WILDLIFE

Riley, C. V., Trans. 19th North Am. Wildlife Natural Res. Conf., March 8-10, 1954. pp 324-337. This paper includes data obtained in Ohio during the peri-

R54-4 (continued)

od 1946-1952 and in Indiana and Illinois during the summer of 1949, on a survey of wildlife population on strip mined reclaimed land compared to the population on adjacent cropland, abandoned farmland and forestland. A 1200 acre tract of land was studied to determine wildlife populations. Animal counts, types of forest trees and ground covers are reported. Many rabbits were trapped as well as raccoons and woodchucks. Fish species were also determined in the various lakes. It was decided that reclaimed coal strip mine land does compare favorably with other areas as producers of wildlife habitats. R269

R54-5 PLANTING REPORT FOR YEAR

Sawyer, L. E., Indiana Coal Producers Association, Division of Forestry and Reclamation, 1946, 5 pp. 1947, 6 pp. 1948, 6 pp. 1949, 9 pp. 1950, 8 pp. 1951, 10 pp. 1952, 10 pp. 1953, 9 pp. 1954, 7 pp. These reports summarize the way in which the planting program was organized and carried out. Tables show the costs incurred, the area planted, and the number and species of trees used at each mine, and whether other planting was done. R880-R888

R54-6 THE SURVIVAL AND GROWTH OF YOUNG HARDWOOD PLANTATIONS ON THE STRIP-MINE SPOIL BANKS OF INDIANA

Tarbox, G. L., Jr., M.S. Thesis, Purdue University, 1954. 136 pp. One year old seedlings of a number of hardwood species were planted in experimental plots on southwestern Indiana surface-mined land selected to represent different soil textures and levels of acidity. Plantings were made in the spring of 1949 and seven survival checks were made through the fall of 1953. A conclusion of the project was that "topography exerts an influence on the growth and survival of most of the hardwood trees --" with poorest growth and survival on machine trails and tops and best in the bottoms. It was felt that a longer time would be needed for a more adequate appraisal but species that appeared to do well were green ash, cottonwood, black locust, silver maple, red oak, sweetgum, and sycamore. Purdue Univ. Lib.

## 1955

R55-1 HARDWOOD TREE PLANTING EXPERIMENTS ON STRIP COAL MINE SPOIL BANKS OF INDIANA

DenUyl, D. (Purdue Univ. Dept. Forestry Conserv.), Purdue Univ. Agr. Expt. Sta., Lafayette, Ind., Sta. Bull. 619, March 1955. 16 pp. This progress report discusses hardwoods planted in 1949 on Indiana spoil banks. Five growing seasons have elapsed since the planting of these trees which were 30 in number. Some 25 million trees have been planted since passage of the reclamation law in 1941. Extensive information describes the many test plots and the characteristics of the spoil material. Many pictures show areas in different stages of growth. The species which are adapted for spoil bank planting are described individually and pictures show the progress of growth. Spoil banks are classified as acid, calcareous and mixed. The summary lists eight types of trees and comments on their suitability for acid spoil planting. R334

### R55-2 COAL SPOIL-BANK MATERIALS AS A MEDIUM FOR PLANT GROWTH

Einspahr, D. W., McComb, A. L., Riecken, F. F., and Shrader, W. D., Proc. Iowa Acad. Sci. 62, 329-344 (1955). This paper reports work on a number of Iowa spoil banks to learn their ability to sustain plant and tree life. Iowa spoil material has a high percentage of particles less than 2 mm in size and their textures are of the silty clay loam type. Liming of the toxic spoil was not practical from an economic standpoint and the results achieved with moderate lime treatments were only temporary. Shale derived soils in southeast Iowa are of low productivity and the very acid spoils weathered at a very slow rate. Best yields were obtained from nitrogen-phosphorus treatments on neutral light gray shale. Black calcareous shales were the spoil materials best suited for plant growth and toxic gray shales of the brownstone type were the least suited. Graphs and tables present data from the various investigations. R327

### R55-3 PROFITABLE STRIPPING---PRODUCTIVE RECLAMATION

Flowers, A. E., Coal Age 60 (5), 108-14 (1955). This article is the story of Harmon Creek Coal Company's stripping and effective reclamation program. This company has built a recreation lake between two spoil banks and has planted over 586,000 trees and shrubs. Trees are raised at the company nursery. Other recreation facilities include swimming and wading pools, and a baseball field all on stripped land. The company also raises pheasants and supplies these for hunting. Backfillings and planting were started in 1944. The company also raises enough field corn to feed the pheasants they raise. A 100 foot strip is left between each 300 feet of trees to prevent spreading of forest fires. The company hired a full-time forester and reclamation foreman. R293

### R55-4 STRIP GRAZING FOR PRIZE ANGUS

Foresman, F. J. (Pittsburg & Midway Coal Mining Co.), Coal Age 60 (9), 74-7 (1955). This article describes the cattle production program of Pittsburg & Midway Coal Co. developed on their strip-mined land in Kansas. The company has grown a herd of 500 Black Angus and Hereford cattle on rich pasture that formerly was strip-mined land. Originally, trees were the only form of reclamation, then sweet clover and Korean lespedeza were very successful. From this the idea to raise cattle resulted and now a large operation exists in breeding registered cattle. Increases in the herd will be made as strip mining operations make more land available for rehabilitation. The farming operation covers 5,000 acres, some of which produces hay and ensilage for winter feeding. R294

### R55-5 STRIP PLANTING FOR BETTER FASTER GROWTH

Wyatt, O. D., Coal Age 60 (8), 80-1 (1955). Planting experiments on West Virginia strip mined land were done by the University of West Virginia. Strip soil was found better than neighboring soil for growing certain trees. Grasses and legumes are better for stopping erosion than trees. When the pH is

R55-5 (continued)

above 6.5, the soil will support hardwoods. Black locust, Norway spruce, and European larch will grow well in spoil material of pH 4 to 5.5. One forester found that grading strip-mined lands showed harmful effects on early development of trees. Birdsfoot clover has been most successful on highly acid soil. R295

R55-6 COAL SPOIL-BANK MATERIALS AS A MEDIUM FOR PLANT GROWTH

Einspahr, D. W., Ph. D. Thesis, Iowa State College, 1955. 197 pp. The comprehensive review of prior work on revegetating spoil banks included effects of grading and subsequent soil compaction; chemical character of spoil and results of weathering; and a summary of earlier investigations of suitable species for planting on spoil banks. Spoil materials investigated in this research were from highwall sections located throughout the Des Moines River coal district of Iowa. The seven types of spoil material characterized chemically and physically were Wisconsin loess, Kansan-Nebraskan glacial till, acid buff shales, acid and toxic gray shales, brownstone shales, calcareous black shales, and Pennsylvanian and Pleistocene sands. The establishment of both tree and forage species on the spoils was studied and recommendations were made for plantings on six spoil materials, but "no tree, grass, or legume species was found suitable for planting on (untreated) acid and toxic gray shales." Included in the vegetative studies were the effects of lime, nitrogen, phosphorus and potassium amendments to the spoils. Vegetation was also affected by drought in 1952 and 1953. Toxic spoil with pH less than 4 seemed to be the greatest problem in reclaiming Iowa surface mined land. Burying these toxic spoils with spoils that support vegetation was recommended as the best method of improving the mined land. The "bench method" of mining which accomplishes this is described. Iowa State Univ. Lib.

R55-7 STRIP COAL MINING: A PROBLEM IN CONSERVATION

Guernsey, L. (University of Louisville), J. Geography 54, 174-181 (Apr. 1955). The author discusses his studies which show that in Vigo County, Indiana, the use of land for agriculture has been decreased due to surface mining. R945

## 1956

R56-1 AQUATIC AND MARGINAL VEGETATION OF STRIP MINE WATERS IN SOUTHERN ILLINOIS

Bell, R., Ill. Acad. Sci. Trans. 48, 85-91 (1956). This study concerned 52 strip-land pools with a pH range of 6.0 to 8.0. Dense growths of pondweed occurred in every pond. Apparently, the ferric oxide precipitates and the negatively charged soil particles keep the pools crystal clear. Densities of the submerged and emergent aquatic vegetation indicated high fertility in the water. Hydrogen ion concentration below 4.0 limited plant growth, and extreme changes in water level was detrimental to willows growth. Other factors discussed are the effect of dissolved oxygen, effect of turbidity, and the age of

R56-1 (continued)

the pool. Many underwater plants and their reactions to various conditions were discussed. 56-29

R56-2 FLEXIBILITY IN STRIPPING

Coal Age 61 (11), 64-7 (1956). The W. P. Stahlman Coal Co. in Clarion, Pennsylvania has extensive stripping operations in northern Pennsylvania and land reclamation is a standard policy. Contours are improved and in some cases the restored land is limed. A Christmas tree program under way involves planting 100,000 trees each year. R204

R56-3 THE RATE OF CARBON DIOXIDE PRODUCTION IN A STRIP MINE SPOIL

Hedrick, H. G. and Wilson, H. A., W. Va. Acad. Sci. Proceed. 28, 11-15 (1956). In this project several chemical agents were used to treat nonvegetated and vegetated spoil materials to see how the treatment affected the rate of carbon dioxide production by soil microbes. Agents used were calcium hydroxide, sodium nitrate, phosphorus as calcium phosphate, potassium as potassium phosphate and nitrogen. Under laboratory conditions the $CO_2$ production was greater when nitrogen was added to the spoil material. Second in importance was the addition of calcium hydroxide to produce a more favorable pH. Phosphorus and potassium had little or no effect on the daily rate of carbon dioxide production. Ground straw was used as a supplemental source of organic matter for use as an energy source by the microbes. R266

R56-4 SPOIL-BANK LANDS RETURN FARM PROFIT IN INDIANA

Sappenfield, V., Coal Age 61 (5), 82-4 (1956). The Sherwood-Templeton Coal Co. of Indianapolis began to reclaim coal-stripped land by planting corn, then expanded and developed farms. A full-time farm manager was hired and a new division known as Maid Marian Farms was established. Spoil land area was then lime treated and used for pasture land. The company experimented with sub-soil fertilizing and several ground covers in an effort to learn which land should be used for farming and which should be planted in trees. Jour

R56-5 A PLACE TO HUNT

Verts, B. J. (Coop. Wildlife Res. Lab., Southern Ill. Univ.), Ill. Wildlife 12 (1) (Dec. 1956). Wildlife development on 924 acres donated by Truax-Traer Coal Co. to southern Illinois University is described. An animal survey was made and the area was opened to the public for hunting and fishing. Surveys of hunters showed that revegetated strip-mine lands can be developed as good public hunting areas. R431

R56-6 VEGETATIONAL FEATURES OF SOME STRIP-MINED LAND IN PERRY COUNTY, ILLINOIS

Brewer, R. and Triner, E. D. (Southern Illinois University), Illinois Academy of Science Transactions 48, 73-84 (1956). Lands mined by Truax-Traer Coal Company between 1932 and 1950 were divided into nine areas representing spoil banks of different ages. Data were obtained on the herbaceous plants, trees, and shrubs in each area. In general, with increasing age of stripped land, there was an increase in the age and size of trees and in the number of tree species. Also, an increase in the age of the mined land seemed to correlate with an increase in perennial species and a decrease in annual species. Occurrence of vegetation was also related to topography of the spoil banks and acidity of the spoil. R963

R56-7 GAME MANAGEMENT PRACTICES ON STRIP MINED LAND

Collins, F. W. (Kentucky Reclamation Association), in Proceedings of the Tenth Annual Conference, Southeastern Association of Game and Fish Commissioners, Little Rock, Arkansas, Oct. 7-10, 1956. pp 213-220. The management of Kentucky surface-mined lands for wildlife is described. The observations of birds, fur-bearing animals and deer, made from 1952-1956, showed that the use of game food and cover plants on mined lands seemed to encourage movement of wildlife into these areas. Five wildlife development and management plans suitable for different conditions are presented. Plants being used on Kentucky mined lands are listed and described. R797

R56-8 AN EVALUATION OF WILDLIFE AND RECREATIONAL VALUES OF A STRIP-MINED AREA

Verts, B. J., M.S. Thesis, Southern Illinois University, 1956. 61 pp. From 1954 through 1956, mammal and bird counts were made on the Pyatt, Illinois, surface-mined land research area, in order to determine the species present, their relative abundance and their distribution in strips of various ages. The vegetation was also noted. A study of hunter and trapper use of the area indicated that management to increase wildlife of the area would also increase use of the area. Development begun under this investigation included road construction, leveling crests of spoil banks, establishing food and cover plants, and building brush piles. Recommendations were made for further development of the area for recreational use. Southern Ill. Univ. Lib.

## 1957

R57-1 TRAPPING THE STRIPLANDS

Arata, A. A. (Coop. Wildlife Res. Lab., Southern Ill. Univ.), Ill. Wildlife 12 (4) (Sept. 1957). Muskrats, raccoons, opossums and a few mink were trapped on the banks of strip-mine ponds in Illinois in the mid 1950's. R432

### R57-2 OBSERVATIONS OF AND RECOMMENDATIONS FOR REFORESTATION PLANTINGS ON AREAS AFFECTED BY OPEN PIT MINING IN THE BITUMINOUS COAL FIELDS OF PENNSYLVANIA

Balsinger, T. R., DeLong, T. S., and Ibberson, J. E., Rept. to Pa. Sec. Forests and Waters and Pa. Sec. Mines Miner. Ind., Oct. 30, 1957. 13 pp. Recommendations made of particular species for revegetating overburden of specific coal seams are based on observations during a tour of bituminous coal fields. R175

### R57-3 RECOVERING STRIPLANDS IN KENTUCKY

Crowl, J. M. Coal Age 62 (3), 77-9 (1957). The formation of the Kentucky Reclamation Association in 1948 was the first attempt to bring together the forester and the agriculturist to help solve the reclamation problem. The Association planted 27 different tree species on strip land, covering a total of 6,985 acres. In this area 4,290,950 trees and game food plants have been planted, and 97,524 lbs of seed have been sown. An average survival has been 65 percent; this is expected to reach 95 percent as more is learned in the process. A number of lakes have been developed and they furnish a good supply of fish. As the land cover develops, many animals and birds are coming in. Jour

### R57-4 DEEP STRIPPING OVERSEAS

Coal Age 62 (11), 74-9 (1957). The reclamation as well as the mining methods at the Acorn Bank Strip Mine near Newcastle, England are described. In the work being carried out by Costain Mining, Ltd., as much as 230 ft of overburden is removed. Jour

### R57-5 EFFECT OF VEGETATION UPON AGGREGATION IN STRIP MINE SPOILS

Wilson, H. A. (W. Va. Agr. Expt. Sta.), Soil Sci. Soc. Amer. Proc. 21, 637-640 (1957). Evaluation of material from vegetated and nonvegetated portions of strip mine spoils and adjacent unmined soils showed that aggregation of undisturbed land is greater than that of vegetated land which is greater than aggregation of barren lands. A good cover of grasses and legumes has a more stimulating effect on aggregation than black locusts which in turn are more effective than pines. R426

### R57-6 FOLIAR ANALYSIS SHOWS VALUE OF SPOILS BANK FOR FRUIT PLANTINGS

Beattie, J. M., Ohio Farm and Home Research 42 (307), 65-67 (July-Aug. 1957). Peach trees were planted on three sites in Ohio, a neutral, a slightly alkaline, and an acid spoil bank. Only the very acid spoil was not suitable for tree growth. Nitrogen fertilizer was needed on the neutral and alkaline spoils, and analysis of leaf samples showed the need for addition of manganese to alkaline spoil. R891

R57-7 SOME ASPECTS OF STRIP MINE RECLAMATION

Harman, N. M. (National Camp Fire Girls, Resource Advisor), Yale Conservation Studies 6, 39-43 (1957). This overview of strip mining and reclamation summarizes information on spoils and their classification and characteristics, and on effects of grading. R903

R57-8 RECLAMATION OF COAL STRIP-MINED LANDS WITH REFERENCE TO WILDLIFE PLANTINGS

Riley, C. V., J. Wildlife Management 21 (4), 402-413 (Oct. 1957). A comprehensive survey of 72 areas in southeastern Ohio was conducted from April 1947 to July 1951 and additional data obtained from June 1954 to October 1955 to evaluate the survival of 37 species of vegetation which had been planted on strip-mined land and which could give food and cover to wildlife. The successful grass, legume, shrub, and tree species are identified and the conditions on which they were found are identified. R816

R57-9 THE POPULATION AND DISTRIBUTION OF TWO SPECIES OF PEROMYSCUS ON SOME ILLINOIS STRIP-MINED LAND

Verts, B. J., J. Mammology 38 (1), 53-59 (Feb. 1957). A survey carried out in Perry County from August 4 to September 29, 1954, indicated a correlation between the distribution of two species of mice and the age of the disturbed area. A second, more intensive survey, from January 17 to May 5, 1955, confirmed the correlation. A detailed description of the vegetation of the areas is given and the author concludes that there are no measureable differences in plant composition between the earliest and latest stripping to explain the difference in the distribution of the species. R937

## 1958

R58-1 BREEDING - BIRD POPULATIONS OF STRIP-MINED LAND IN PERRY COUNTY, ILLINOIS

Brewer, R., Ecology 39 (3), 543-545 (1958). This paper is a study of bird population on a tract of land strip mined between 1932 and 1950. Forty-four breeding species were counted and classified as forest edge birds. Most abundant of the species were the field sparrow, indigo bunting, mourning dove, and cardinal. A complete list of the bird species is tabulated. R265

R58-2 RECLAIMING ILLINOIS STRIP COAL LAND WITH LEGUMES AND GRASSES

Grandt, A. F. and Lang, A. L., Univ. Ill., Agr. Expt. Sta., Bull. 628 (1958). 64 pp. Characteristics of the soil material, species adaptation, and the utilization of strip-mined lands are detailed. Mined lands have also been classified on the basis of acidity and texture of the soil material. R611

### R58-3 PERFORMANCE OF TREES PLANTED ON COAL-STRIPPED LANDS IN THE BITUMINOUS REGION OF PENNSYLVANIA

Hart, G. E. and Byrnes, W. R., Pa. State Forest School, Res. Paper No. 28 (undated). 2 pp. This paper gives the results of observations of 22 test plantings from 10-13 years old in 15 counties of Pennsylvania. In 1958, the measurements were converted to a 10 year base and the tree growth rated. The study showed it is desirable to plant trees in small blocks of 5 to 7 rows wide. Four shrubs (black chokeberry, silky dogwood, hazelnut and arrowwood) which provide food for wildlife were also planted in the test areas and have developed normally. The 10-year data are tabulated. R194

### R58-4 RECLAMATION OF A SPOIL-BANK AREA FOR WILDLIFE PURPOSES

Birkenholz, D. E., M.S. Thesis, Iowa State College, 1958. 70 pp. This study is the second in a long-term investigation made to determine effective methods of developing and managing spoil-bank areas for wildlife and recreation. The study area, 920 acres of surface-mined land in Perry County, Illinois, is known as the Pyatt Striplands Research Area. Selected sections were leveled and planted. Detailed wildlife censuses were made using feeding and trapping techniques. Data on fish were collected by questionnaires sent to fishermen. Soil samples were analyzed to determine pH and lime and fertilizer requirements for seeding. Soil pH ranged from 4.5 to 8.2 and did not correlate with age of spoil banks. Vegetative surveys were made. In order to eliminate species competing with plants yielding food and cover for wildlife, spoils were leveled, burning was carried out, and chemical weed-killers were used. Generally, spoil-bank leveling was necessary to establish desirable plants. Iowa State Univ. Lib.

### R58-5 RECLAMATION OF STRIP-MINED LANDS IN VIGO COUNTY, INDIANA

Guernsey, L. (Indiana State Teachers College), Indiana Academy of Science Proceedings 67, 215-224 (1958). The author describes the grading and planting of spoil banks carried out by Indiana coal producers in compliance with reclamation laws. His studies show less compaction of mined land due to grading than other studies have shown. The use of reclaimed land for recreation, including fishing, and for home building is also noted. R941

### R58-6 CONIFER GROWTH AND SURVIVAL VARIES ON ACID SPOILS

Lowry, G. L., Reprinted from Ohio Farm and Home Research 43 (311) (March-April 1958). 2 pp. Eight conifer species were grown on spoil banks in 5 Ohio counties. Toxic, strongly acid, and mildly acid spoil classifications are represented. After two years of testing, pitch pine showed best growth and survival on toxic and highly acid spoils. White cedar performed best on mildly acid spoil. R815

## 1959

R59-1 THE ECOLOGY OF MUSKRATS IN STRIP-MINE PONDS IN SOUTHERN ILLINOIS

Arata, A. A. (Coop. Wildlife Res. Lab., Southern Ill. Univ.), J. Wildl. Manage. 23 (2), 177-186 (1959). This study showed that while strip mine ponds did support muskrat, a number of adverse environmental factors probably contributed to low reproductive rates. Recommendations for improving strip mine ponds as muskrat habitat include leveling the banks, elimination of rock, use of economical water-level control devices, and the development of greater areas of shallows to encourage growth of aquatic vegetation. R453

R59-2 TREE SPECIES RECOMMENDED FOR STRIP-MINE PLANTATIONS IN WESTERN KENTUCKY

Boyce, S. G. and Merz, R. W., U.S. Forest Serv., Central States Forest Expt. Sta., Tech. Paper 160 (1959). 12 pp. Ten years of observations of strip mine tree planting in western Kentucky are recorded. Tests started in 1948 on area about 5 miles west of Madisonville, Kentucky, show that successful plantings can be made if species are properly selected for various sites and if good-quality stock is used in the planting. A number of different species were planted in mixtures or in pine plantings. Survival and growth varied widely among sites and species. R58

R59-3 TREES FOR PLANTING ON STRIP-MINED LAND IN ILLINOIS

Boyce, S. G. and Neebe, D. J., U.S. Forest Serv., Central States Forest Expt. Sta., Tech. Paper 164 (1959). 33 pp. Seventeen species of trees were found suitable for planting on strip-mined land in Illinois. Ten species were suitable for planting in all parts of the state; seven additional species were suitable for the southern counties. The best survival and growth was obtained where species were carefully selected for the various sites and only the best quality stock was planted. The species selected and their suitabilities are listed. (From authors' summary)

R59-4 PROGRESS REPORT ON THE RECLAMATION AND REFORESTATION OF STRIP-MINED AREAS IN CENTRAL PENNSYLVANIA

Jones, W. G., Central Pa. Open Pit Mining Assoc., Conserv. Div., April 1959. 16 pp. This colorful brochure illustrates the process of reclamation by planting trees. Many areas are shown in various stages of development. R283

R59-5 THE POTENTIAL OF WILDLIFE MANAGEMENT ON STRIP-MINED AREAS

Klimstra, W. D. (Coop. Wildlife Res. Lab., Southern Ill. Univ.), Ill. Wildlife 14, 5-9 (1959). The roles of vebetation and of water in the occurrence of wildlife on strip-mined land are discussed. R433

R59-6 NOTES ON THE ECOLOGY OF MAMMALS OF A STRIP-MINED AREA IN SOUTHERN ILLINOIS

Verts, B. J. (Southern Ill. Univ.), Trans. Ill. Acad. Sci. 52 (3, 4), 134-139 (1959). This article describes an ecological study of the wildlife potential of coal strip-mined lands in southern Illinois conducted August 4, 1954 to May 30, 1956. The area concerned had been strip mined from 1932 until 1950. A systematic count gave evidence of 26 species of mammals which were categorized into four ecological groups. It is suggested that changes in physical conditions due to increased height and canopy size of trees may be sufficient to initiate changes in mammal distribution. R427

R59-7 LAND USE CHANGES CAUSED BY A QUARTER CENTURY OF STRIP COAL MINING IN INDIANA

Guernsey, L. (Indiana State Teachers College), Indiana Academy of Science Proceedings 69, 200-209 (1959). Data discussed, tabulated, and illustrated by maps for the counties where mining has taken place include amount of land surface mined, area that was formerly in cropland, acreage revegetated by trees and by grasses and legumes, amount used for recreation, and idle spoils. R951

## 1960

R60-1 ESTABLISHMENT OF SEEDED BLACK LOCUST ON SPOIL BANKS

Brown, J. H. and Tyron, E. H., W. Va. Univ., Agr. Expt. Sta., Bull. 440 (1960). 34 pp. Success in revegetating spoil banks by seeding with black locust seemed to depend on spoil pH, time of seeding, amount of precipitation, and steepness of slope. R630

R60-2 CONDITIONS RESULTING FROM STRIP MINING FOR COAL IN TENNESSEE

Tenn. Dept. Conserv. Commerce and Tennessee Valley Authority, April, 1960. 13 pp.+ This booklet is essentially a picture presentation of strip mining and reclamation. A survey of strip mined areas was conducted by the state of Tennessee and TVA and results of this survey are summarized. A map shows the principal strip mines in Tennessee by counties. R284

R60-3 STRIP PITS AND THE SANITARY LANDFILL PROCESS

Deasy, G. F. and Griess, P. R., Miner. Ind., The Penn. State Univ. 30 (2), 1, 4-6 (Nov. 1960). The use of strip pits as sanitary land fills is recommended. Most pits are far enough from the highways to be out of sight for travelers and yet are accessible and within reasonable distance of populated areas. Additional productive land can be created at the same time that abandoned strip mine areas are reclaimed. R613

R60-4 PIONEER SHALE BANK COMMUNITIES

Ehrle, E. B., Castanea 25, 80-83 (1960). Herbaceous pioneer plants and the shrubs and trees following were found to be similar on shaly roadsides and on shale banks at strip mines in the Allegheny Plateau section of central Pennsylvania. Relatively stable, rather than successional, plant communities were found in shaly situations in the Valley and Ridge Province bordering the Plateau to the south and east. R449

R60-5 HOW PRECIPITATION AFFECTS STRIP-MINE POND WATER LEVELS IN SOUTHEAST OHIO

Hill, L. W., USDA, Central States Forest Expt. Sta., Columbus, Ohio, May 1960. 2 pp. Some measurements were made on a 5-acre pond near Ironton, Ohio to find out how rainfall affects the water level. The pond has no outlet and all water enters from spoil bank runoff and rainfall. A table shows ratios for pond-level rise in inches for various amounts of rainfall. R12

R60-6 FORESTATION OF STRIP-MINED LAND IN THE CENTRAL STATES

Limstrom, G. A., U.S. Dept. Agr., Agr. Handbook No. 166, (Feb. 1960). 74 pp. The information obtained from research begun in 1937 and from a project begun in 1945 is in this guide to forestation of strip mined land. Characteristics of overburden and their effects on establishment and growth of trees are discussed. Several tree species have been successfully grown but insects, diseases, quality of planting stock, whether pure or mixed plantings are used, and configuration of trees set out all can affect forestation. R61

R60-7 THE ECOLOGY OF WATER AREAS ASSOCIATED WITH COAL STRIP-MINED LANDS IN OHIO

Riley, C. V. (Kent State Univ.), Ohio J. Sci. 60 (2), 106-121 (March 1960). This paper discusses the effects of various methods of mining and of the characteristics of the overburden on the condition of water in strip mined areas. The results of a survey of fish, aquatic life, wildlife, and vegetation in and around strip mined lakes are reported. A laboratory study confirmed the acid producing effect of $FeS_2$ in various strata of overburden and that such acid water would kill fish. R83

R60-8 LAND RECLAMATION

Schoewe, W. H. (Univ. Kan.), Reprinted from Mining Congr. J., Sept.-Oct. 1960. 11 pp. The over-emphasis on the spoil bank problem, mandatory reclamation requirements, strip mining effects and reclamation benefits, land use for worthwhile purposes, the right of eminent domain, soil erosion, stream pollution, health hazards, and dangers to life and property are discussed. Other considerations of importance are water conservation, income to the land owner and revenue for taxation, objections to mandatory reclamation and recommendations. R282

R60-9 FORAGE SEEDINGS HELP RECLAIM ACRES OF SPOIL BANKS

Struthers, P. H., Reprinted from Ohio Farm Home Res. 45 (1), (1960). 2 pp. Field trials of grasses and legumes on strip-mined land in Ohio since 1952 have shown that generally species that do best on farm land are also best for strip-mine use. R166

R60-10 TWO ENGINE DIESEL SHOVEL PACES THREE-STEP STRIPPING AT HARDY COAL

Coal Age 65 (7), 96-8 (1960). This article describes a stripping method primarily, but it also includes graphic sketches showing how the overburden is handled and the spoil material placed so that it can be covered later. This area is then planted with trees or fertilized and seeded where grade is level enough for farming. The method is called a three-step one and uses a Caterpillar D8 to push shale against the spoil from a previous cut. R301

R60-11 THE RECLAMATION OF STRIP MINED LANDS IN WESTERN KENTUCKY

Guernsey, L. (Indiana State Teachers College), J. Geography 59 (1), 5-11 (Jan. 1960). Reclamation techniques discussed include grading and revegetation which has been particularly successful with a mixture of hardwood trees. Grasses and legumes have been successfully grown on spoil with a pH of 6 or higher. R949

R60-12 STRIP MINE AREA RECLAMATION

Memorandum to Representative W. K. Davidson, Illinois Legislative Council File No. 3-678, Feb. 1, 1960 (P. 504) JTM. 21 pp. Laws enacted in Illinois on this subject prior to the date of this memorandum were written in such a way that they had been ruled unconstitutional. This discussion of surface mining, and its regulation and requirements for reclamation, emphasizes the laws in other mining states and the way in which they are drawn up as a natural exercise of the police power of the state to uphold the public interest. Controversies on the possibility of successful reclamation, on the economic effects of surface mining, on costs of reclamation, and on the potential uses of reclaimed lands are summarized. Coal-company programs of reclamation in Illinois as well as in other states are reviewed. R826

## 1961

R61-1 A BIBLIOGRAPHY OF STRIP-MINE RECLAMATION, 1953-1960

Bowden, K. L., Univ. Mich., Dept. Conservation Jan. 30, 1961. 13 pp. This is an update of "A bibliography of strip-mine reclamation," by Limstrom published in 1953. There are 152 references. R429

## R61-2 CROWN VETCH AS AN AID TO STRIP MINE RECLAMATION

Breeding, C. H. J., Mining Congr. J. 47 (4), 70-71 (April 1961). Crown vetch has been successfully used for slope erosion control. Since one disadvantage is the three year development period, other legumes are mixed with it in order to get a first year coverage. Crown vetch also makes a good cattle feed as shown by the fact that Hanna Coal Company recorded weight gains up to 2 lbs/day in their herd. R85

## R61-3 LAND RESTORATION FOLLOWING MINERAL EXTRACTION AND DEPOSITION OF WASTE MATERIALS

Davies, W. M., J. Roy. Agr. Soc. Eng. 122, 26-38 (1961). The Ministry of Agriculture is responsible for all after-treatment of worked land in England before it is returned to the owners and occupiers. There are several government organizations which regulate the surface mining industries. A list of the various minerals obtained by surface mining is included together with recoverable percentages and acreage. Following physical restoration, the land is subjected to a five-year treatment designed to restore fertility. R336

## R61-4 EUROPEAN ALDER: A PROMISING TREE FOR STRIP-MINE PLANTING

Funk, D. T. and Dale, M. E., USDA, Central States Forest Expt. Sta. Note No. 151, Sept. 1961. 2 pp. In this project several hundred European alder tree seedlings were planted in seven experimental plots in Kentucky and Ohio. All sites were acid with the average pH ranging from 3.0 to 4.6 and some individual readings were as low as 2.4. After 3 years, the survival and growth of these alders were very good on all but the most acid parts of the plots. The minimum pH at which good growth rate is attained appeared to be 3.5. This experience proved that European alder will be a valuable species and could replace the black locust which has been the standard nurse tree for strip-mine land. R20

## R61-5 SOME PHYSICO-CHEMICAL PROPERTIES OF WEATHERING COAL

Lowry, G., PhD Thesis, Mich. State Univ., 1961. 142 pp. University Microfilms Inc., Ann Arbor, Mich. 61-4968. This publication describes a 21 month project to determine what effect soil-forming factors have on rate and magnitude of physical and chemical changes occurring in spoil materials and to determine what site and soil factors affect tree seedling survival and growth. Nineteen spoil samples from Ohio were selected and were trucked to the experiment station at Wooster. Details of sample preparation are given, as well as the testing procedures. Measurements of rainfall, leachate, and runoff for the 21 month period were recorded. Results indicated that Ohio coal spoils weather quite rapidly. Many chemical and physical and biological changes were noted in this relatively short study. The author estimated that a period of perhaps 5 to 25 years would be required for toxic spoils to leach sufficiently to permit successful plant establishment. R219

R61-6 OUTDOOR RECREATION AND ITS RELATION TO THE MINING INDUSTRY

Am. Mining Congr., 1961. (20 pp). This small booklet emphasizes the importance and size of recreation industry in United States. Statistics show the numerical size of this field and pictures show various areas, many developed by reclamation of mined areas. Mining creates outdoor recreation opportunities. Even "ghost towns" are scenic attractions related to mining. R227

R61-7 RECLAMATION PROJECT YIELDS A PROFIT

Coal Age 66 (11), 120-2 (1961). This is the story of Hanna Coal Co. of Cadiz, Ohio and its crown vetch seeding program for spoil banks. The company has used this plant to control erosion on spoil banks. The seeding is done by helicopter. The company later began to raise cattle on the reclaimed land. The company then built a seed recovery plant and now sells the excess seed to seed houses and in 1961, recovered 27,000 lbs of seed. R302

R61-8 SEEDED BLACK WALNUT TALLER THAN PLANTED WALNUT ON KANSAS SPOIL BANKS

Seidel, K. W., U.S. Dept. Agr., Central States Forest Expt. Sta. Note No. 148 (1961). 1 p. Direct-seeded black walnut trees survived as well as and grew faster than planted trees in a study conducted on four year old Kansas spoil banks in Cherokee County. Ten years after planting, a 1,500 tree sample showed that trees from direct-seeded walnuts were significantly taller than the planted trees but there was no great difference in survival or form between them. R155

R61-9 LAND USE CONTROL IN THE SURFACE EXTRACTION OF MINERALS PART I

Stollman, I., Amer. Soc. Planning Officials Inform. Rept. No. 153, Dec. 1961. 18 pp. This report gives information on many minerals in addition to coal. Characteristics of each industry are discussed, together with planning problems, zoning law and surface mining, judicial solicitude and a section on the nonconformity of mining. R285

R61-10 180,000 STRIPMINE ACRES: OHIO'S LARGEST CHEMICAL WORKS

Struthers, P. H., Reprinted from Ohio Farm Home Res. 46 (4), (1961). 2 pp. Chemicals leached from Ohio strip-mine spoils are described. It is suggested that the ready availability of minerals may account for the acid tolerance of many plants on strip-mine spoils. R167

R61-11 AN ASSESSMENT OF THE REPLANTING OF SOME OPEN CAST COAL SITES IN SOUTH YORKSHIRE

Voysey, J. C., Quart. J. Forestry 55, 24-34 (1961). In the West Riding, 27 sites totaling 312 acres were surveyed. Planting on these sites had been done

R61-11 (continued)

from 1949 to 1959. Factors in successful tree establishment were identified as soil cultivation to aid in restoring soil structure; planting normal size nursery stock instead of sowing or using seedlings or larger stock; and choice of species with grey and common alder, Corsican pine, and to a lesser extent Japanese larch showing best results of the species used. R416

R61-12 SETTLEMENT CHANGES CAUSED BY STRIP COAL MINING IN INDIANA

Guernsey, L. (Indiana State Teachers College), Indiana Academy of Science Proceedings 70, 158-164 (1961). Population and land-use changes in Indiana coal-mining counties were compared to those in areas where there had been no mining. The author concludes that the comparison "demonstrates that strip mining causes some instability of settlements but not enough to have caused the population decline of 7,198 persons--and that the lag between present industrial development and southwestern Indiana's industrial potential appears to be the primary reason for the general population decline." The survey showed a decrease in the number of individual farms, the creation of more irregular and smaller fields, and the change from single farm units into more complex tracts. However, in the majority of townships where mining took place, farms remained unchanged. Other changes in the mined areas were that roads were of better quality and were laid out according to a more random pattern, and that a large number of semiurban dwellings were now located on mined lands. R943

## 1962

R62-1 TREES AND ENOS

Anderson, J. I. (American Forest Products Ind., Inc.), Coal Age 67 (6), 90-1 (1962). The Reforestation Program of the Enos Coal Co. of Oakland City, Indiana started back in 1926 when 1400 trees were planted. Harvesting of planted trees has already begun as of the date of this article. White pine is considered preferable to locust once thought to be an ideal tree. European alder is an economically important forest tree. All Enos tree activities have been coordinated by L. E. "Buck" Sawyer, Conservation Director for the Midwest Coal Producers Institute. The new forests are helping to re-establish wildlife in the area after sufficient ground cover becomes available. R303

R62-2 STRIP-MINE RECLAMATION: A DIGEST

Bergoffen, G. S. (Forester), Eastern Region, Forest Serv., U.S. Dept. Agr., 1962. 49 pp. The literature listed in a Forest Service Bibliography published in 1953 and in one published in 1960 was reviewed for this digest. The state-of-the-art of reclamation is discussed in detail under the general topics "Spoils characertistics influencing revegetation;" "Forest planting and revegetation;" and "Potential uses of strip-mined land." There are synopses of strip-mine reclamation legislation in effect in Indiana, Kentucky, Maryland, Ohio, Pennsylvania, and West Virginia at the time of publication of the digest.

R62-2 (continued)

Forty-six publications cited in the discussion are listed. Material from the two bibliographies used as source are categorized in "Guide to Planting Recommendations by Region and by State," and in "Guide to Reclamation Literature Reviewed by Region and by State." R577

### R62-3 STRIP REVEGETATION

Brohard, E., Coal Age 67 (3), 64-5 (1962). This author explains that soil sourness is the number one problem on stripped areas. The article shows several pictures illustrating various stages of planting and soil preparation. Fertilizer and lime application formulas are included as necessary for extremely acid soil. A sweet strip spoil can be revegetated quite readily. The main objective is to make the right decision so that the land can be developed in the shortest possible time. R307

### R62-4 SUCCESS OF TREE PLANTING ON STRIP-MINED AREAS IN WEST VIRGINIA

Brown, J. H., W. Va. Univ. Agr. Expt. Sta., Bull. 473 (1962). 35 pp. Plantings from two to twelve years old on over 100 spoil banks in 18 counties were surveyed in this study. Although survival ranged from 20 to 92 percent, the average throughout the state was over 67 percent. While site factors had an effect on survival of trees, poor planting practices also had a major adverse effect. R631

### R62-5 INFLUENCES OF STRIP MINING ON THE HYDROLOGIC ENVIRONMENT OF PARTS OF BEAVER CREEK BASIN, KENTUCKY, 1955-1959

Collier, C. R., U.S. Geol. Surv. Prof. Paper 427-B (1962). 276 pp. This report presents the results of a study of the influences of strip mining in the Beaver Creek Basin during the period 1955-59. Strip mining has occurred in about 10 percent of the Cane Branch area since 1955. The Helton Branch area has had no mining activity. A comprehensive comparison of chemical content, flooding characteristics, effect on aquatic life and on flora and fauna in these areas is presented. R63

### R62-6 PLANTATIONS ON STRIP-MINE BANKS CAN YIELD TIMBER PRODUCTS

Davis, G. and Melton, R. E., Pa. State Forest School, Res. Paper No. 29 (1962). 2 pp. Ten of the oldest plantations on ungraded spoils were measured after 25 years or converted to a 25-year base to determine how well strip-mine banks can produce timber products. R195

### R62-7 A REVISED BIBLIOGRAPHY OF STRIP-MINE RECLAMATION

Funk, D. T., Central States Forest Expt. Sta., Columbus, Ohio, Misc. Release

R62-7 (continued)

35 (1962). 20 pp. This publication contains a list of 172 references mainly concerning vegetation and all related phases of reclamation work done on mined-land. 62-63

R62-8 A LYSIMETER FOR STUDYING THE PHYSICAL AND CHEMICAL CHANGES IN WEATHERING COAL SPOIL

Lowry, G. L. and Finney, J. H., Ohio Agr. Expt. Sta., Res. Circular 113, (Aug. 1962). 17 pp. This article describes a project to measure volume and weight loss of spoil samples exposed to the weather. Lysimeters (plastic cylinders) were filled with a definite volume of spoil material. Perforated base allows leachate to escape. Nineteen spoil samples were used in addition to a silt loam. 62-112

R62-9 CONSCIENTIOUS COAL STRIPPING

Montgomery, H. B., Coal Age 67 (7), 84-8 (1962). This article describes the stripping operations of the D. G. Wertz Coal Company near Renovo, Pennsylvania. This company, cooperating with the Dept. of Forests and Waters, follows a strict reclamation practice which is particularly careful of existing trees. Topsoil is removed and handled separately so that it can be used to cover rocks and bony material as soon as possible. Poor quality coal is saved for blending. Careful procedures have enabled the company to recover 7000 tons/acre which is significant. The backfilling contract requires that not more than 1000 ft of cut be left exposed for more than 6 months. Cost figures showed that even with the extra care and work involved, the figure averaged 4 to 7 cents per gross ton of coal mined. Details of economic benefits to the area are included. R308

R62-10 REPORT ON A SURVEY OF POTENTIAL RECREATIONAL UTILIZATION OF ILLINOIS STRIP-MINED LAND

Roseberry, J. L. (Cooperative Wild Life Res. Lab., Southern Ill. Univ.), Midwest Coal Producers Inst., Inc., 1962. 10 pp.+ This comprehensive treatment of reclaimed strip-mine land in Illinois emphasizes recreational use of the reclaimed land. A tabulated list by counties totals the strip acreage in Illinois and another tabulation shows ownership of the different areas. Actual acreage presently in use for recreation is listed and another table lists stripped acreage and its individual potential relating to recreational use. A number of pictures are included giving credence to the success so far of the recreational utilization. A variety of factors determine the suitability of an area for recreational use and these are enumerated. A state map shows the 5 strip mining districts in Illinois. R326

R62-11 MIXED OR PURE WALNUT PLANTINGS ON STRIP-MINED LAND IN KANSAS?

Seidel, K. W. and Brinkman, K. A., U.S. Dept. Agr., Central States Forest Expt. Sta., Tech. Paper 187 (1962). 10 pp. Ten years after planting pure stands of black walnut were found to have better survival, greater height, and better form than walnut grown in mixture with black locust. On the basis of this study, black walnut should be planted with bur oak, sycamore, red cedar or green ash on spoil banks in southeastern Kansas. A logical mixture might consist of equal amounts of selected species. (From authors' summary) R154

R62-12 RESPONSE OF BOBWHITE QUAIL TO MANAGEMENT ON SOME ILLINOIS STRIP-MINED LANDS

Vohs, P., Jr. (1) and Birkenholz, D. E. (2) [(1) Iowa State Univ. (2) Univ. Fla.], Ill. Acad. Sci. Trans. 55 (1), 13-19 (1962). Responses of bobwhite quail to management practices applied on 920 acres of strip-mined land in southern Illinois have been studied since 1954. Practices employed included road construction, grading of spoils and widening of spoil valleys, manipulation of cover and introducing plant species which produce food for quail. An increase of bobwhites from 46 prior to incorporation of management to 279 in 1959-60 was recorded. An analysis of the crops of 49 quail obtained in 1959-60 indicated a dependence of the birds on plant species introduced through management. (From authors' summary) R424

R62-13 THE ADMINISTRATION OF THE ILLINOIS STRIP MINE RECLAMATION ACT

Weber, L. S., Proc. Ill. Mining Inst. Ann. Meet., Nov. 16, 1962. pp 52-59. This paper reviews the history of strip-mine legislation in Illinois, and discusses requirements of the law passed August 10, 1961. The Department of Conservation administers the law, provides inspections and processes permits. R479

R62-14 SURVIVAL AND GROWTH OF HARDWOOD PLANTATIONS ON STRIP MINE SPOIL BANKS OF INDIANA

DenUyl, D., J. Forestry 60, 603-606 (Sept. 1962). Of ten species of trees planted on spoil banks and observed for eleven growing seasons, only cottonwood on one plot reached crop tree size. The author concluded that another ten years of observation would be needed to evaluate species for selection for planting on spoil banks. R953

R62-15 TRENDS IN ECONOMICS OF MINED AREA RESTORATION

Sauer, E. L. (University of Illinois, College of Agriculture), 17th Annual Meeting, Soil Conservation Society of America, Washington, D.C., Mined Area Restoration Committee Symposium, Aug. 27, 1962. pp 107-119. Paper No. 108-D. This survey of the costs of reclamation of coal-mined land in Illinois, Indiana, Kentucky, Missouri, Ohio, Pennsylvania, and West Virginia and of land

R62-15 (continued)

mined for sand and gravel in several midwestern states includes information on reclamation methods and on the uses of reclaimed land. R879

R62-16 MINED AREA RESTORATION IN INDIANA

Sawyer, L. E. (Mid-West Coal Producers Institute), J. Soil and Water Conservation 17, 65-67, 76 (March-April 1962). Early research on reclamation by Purdue University and the Central States Forest Experiment Station and progress in reclamation in Indiana are reviewed. R889

## 1963

R63-1 AN APPRAISAL OF COAL STRIP MINING

Tennessee Valley Authority, 1963. 13 pp. This report reviews the progress of strip mining from World War I and follows the development in the five states where TVA buys coal: Kentucky, Tennessee, Illinois, Virginia, and Alabama. Subjects discussed separately are extent of stripping, stripping methods, type of land stripped, effects of stripping, erosion, land values, reclamation experience in grading, reforestation, recreation and wildlife, reclamation costs, and legislation. Tabulated data give areas stripped in Tennessee Valley counties through 1961. Records are also shown on coal production in selected states and TVA deliveries from those states. R210

R63-2 INTERPLANT ALDER TO INCREASE GROWTH IN STRIP-MINE PLANTATIONS

Dale, M. E. (Central States Forest Expt. Sta., USDA), U.S. Forest Serv. Res. Note CS-14 (1963). 4 pp. Results from a 5-year-old planting indicate that European alder is beneficial as a nurse crop to other tree species on a strip mined area in eastern Kentucky. The nursing effect of alder did seem to stimulate height growth of 10 species, some more than others. (From text) R407

R63-3 TREES FOR GRADED STRIP-MINE SPOILS--PERFORMANCE RATINGS FOR 15 SPECIES COMMONLY PLANTED IN THE BITUMINOUS REGION OF PENNSYLVANIA

Davis, G. and Melton, R. E., The Pa. State Forest School, University Park, Pa., Res. Paper No. 32, Feb. 15, 1963. 4 pp. This is a cooperative study of 6 different agencies to investigate all phases of the problem of revegetating strip-mine spoils in Pennsylvania. This survey concerned tree survival and growth of plantations on graded banks to supplement information already obtained from ungraded banks. A table is included showing spoil characteristics of the major coal seams stripped in Pennsylvania. R24

R63-4 COAL STRIP MINE RECLAMATION

Deasy, G. F. and Griess, P. R., Mineral Industries 33 (1), 1, 3-7 (1963). The

R63-4 (continued)

strip-mining problems, methods of treating stripped lands and results, implications of recent trends in stripped land, legislation, and some problems associated with specialized renovation of stripped lands are discussed. R456

### R63-5 A GUIDE FOR SCREEN AND COVER PLANTING OF TREES ON ANTHRACITE MINE-SPOIL AREAS

Frank, R. M. (Northeastern Forest Expt. Sta., USDA), U.S. Forest Serv. Res. Paper NE-22 (1963). 50 pp. Areas disturbed by coal mining in Pennsylvania were mapped, and potential planting sites necessary to screen them from view or to cover them were delineated. Number of seedlings needed for a planting program was estimated. Areas shown on maps were classified according to kind of spoil, density of present tree cover, and visibility. Maps were prepared for major communities, counties, and for the entire Anthracite Region. (Forest Serv. Abs.) R197

### R63-6 HYBRID POPLARS ON OHIO SPOIL BANKS

Funk, D. T. (Central States Forest Expt. Sta., USDA), U.S. Forest Serv. Res. Note CS-8, June 1963. 4 pp. This article describes a program started in 1951 in Harrison County, Ohio. Fifty hybrid poplar clones were used and 16 stem cuttings of each clone were planted in each of two strip-mined areas. The hybrid poplars survived better and grew faster on Sewickley than on Pittsburgh spoils. Extensive data on the experiments and a detailed description of the spoil-bank areas are included. R21

### R63-7 STRIP MINING RECLAMATION AND THE PUBLIC

Jackson, D., Jr., Coal Age 68 (5), 84-95 (1963). This article is a very comprehensive discussion on the subject of reclamation and its related effects. Many pictures show projects in progress and several final results. The article points out that if all the coal in the state were recoverable by strip mining, only 3% of the state total land area would be disturbed. About 85% of the state's reserves lie in thin seams. Reclamation actually makes the land more valuable which is an added contribution to the economy. Included in the article are references to State and Federal projects and summaries of other related efforts, efforts of the open pit operators, and the work of the State Soil Conservation Commission, particularly as it relates to erosion and flood control. R310

### R63-8 STRIP-MINED LANDS FOR RECREATION

Klimstra, W. D., Vohs, P. A., Jr., and Cherry, J. W. (Southern Ill. Univ., Coop. Wildlife Res. Lab.), Ill. Wildlife 18, 6-8 (1963). The Pyatts Research area was formerly strip mined by Truax Traer Coal Co. The development and use of these lands for recreation is described. R428

R63-9 FOREST PLANTING PRACTICE IN THE CENTRAL STATES

Limstrom, G. A., U.S. Dept. Agr., Forest Service, Agriculture Handbook No. 247, Dec. 1963. 69 pp. This comprehensive publication describes the factors that affect the success of tree planting on different types of land. Site preparation is important. Planting instructions are illustrated. The choice of stock and the care of plantations are also discussed. R506

R63-10 PREDICTING OUTSLOPES OF SPOIL BANKS

May, R. F. (Central States Forest Expt. Sta., USDA), U.S. Forest Serv. Res. Note CS-15 (1963). 4 pp. A method of predicting the downslope area of strip-mine disturbance from the proposed highwall height and the original slope angle is presented. R78

R63-11 DESCRIPTION OF PHYSICAL ENVIRONMENT AND OF STRIP-MINING OPERATIONS IN PARTS OF BEAVER CREEK BASIN, KENTUCKY

Musser, J. J., U.S. Geol. Surv. Prof. Paper 427A (1963). 25 pp. An investigation of the effects of strip mining for coal on the hydrology of parts of the Beaver Creek basin, McCreary County, Kentucky was begun in 1955. This report describes the topography, drainage, geology, soils, climate, hydrologic environment, and forest vegetation of the study areas and gives a history and description of the mining. R64

R63-12 RECLAIMING LAND FOR PROFIT

Coal Age 68 (10), 94-101 (1963). Ayrshire Collieries, in the 10 years preceding this article, has reforested a total of 3420 acres of spoil and developed a number of farms and formed Meadowlark Farms Division. Each individual farm, Chinook, Sullivan County Dairy Farm, Pike and Warwick, Denmark Farm, Gibraltar Delta, Fairview, Fulton Harmattan, is described and particular details of each farm are given. Ayshire also donates certain areas to organizations such as the Boy Scouts, National Guard and Indiana Geological Society. R311

R63-13 RESPONSIBLE STRIP MINING AND RESTORATION

Coal Age 68 (1), 28 (1963). This article describes the formation of the Pennsylvania Conservation Association, a group representing the Open Pit mining industry in Pennsylvania. This organization began its first project on an 1100 acre tract in Clearfield County. The organization invited all interested people to visit this project to watch open-pit operations, backfilling and water control procedures. The area also has a facility for testing rate of growth of vines and other ground cover. Also in the area is an example of a mined pit which operated before passage of the Strip Act. Another of the major functions of the organization is development of land use studies. R309

R63-14 REVEGETATION AND MANAGEMENT OF CRITICAL SITES FOR WILDLIFE

Riley, C. V., Trans. 28th North Am. Wildlife Natural Res. Conf., 269-283 (1963). The objectives of this study were to field test and evaluate the adaptability of various plant species having possible value to wildlife on sites varying in acidity and toxicity; to develop wildlife management techniques, and to apply these methods both during initial reclamation of strip lands and to older established plant communities. Characteristics of the strip mine sites are listed together with the analytical conditions of the soil on the stripped and undisturbed land. Tabulated evaluations are included for trees, grasses, and legumes, shrubs and vines. A total of 78 composite soil samples were tested, 85 plant species were field tested on 107 strip-land plots and 57 species were rated as being successful. R335

R63-15 CROWNVETCH IN WEST VIRGINIA

Ruffner, J. D. and Hall, J. G., W. Va. Univ., Agr. Expt. Sta. Bull. 487 (1963). 19 pp. Planting on strip-mine spoils in West Virginia was one of the uses of crown vetch evaluated over the years. Plantings failed on spoils more acid than pH 5.5 and on clayey compacted spoils. R193

R63-16 THE UNITED ELECTRIC COAL COMPANY'S LAND-USE PROGRAM

Seastrom, P. N., American Mining Congress Comm. on Strip Mining, Committee Report 8/28/63. This unpublished committee report describes the reclamation program of United Electric Coal Company at their Fidelity Mine in Southern Illinois. This work was started in 1938 and in 1963 at their Fidelity Mine there were 2000 acres of pine and hardwoods. In addition 500 head of cattle graze on 1200 acres of pasture, 135 acres of orchards are producing thousands of bushels of fruit and many people enjoy hunting and fishing each year. This program was initiated voluntarily and it was not until 1962 that a reclamation law was put into effect. R521

R63-17 SIX STEPS OF EFFICIENT THREE SEAM STRIPPING

Coal Age 68 (8), 62-5 (1963). The mining methods and reclamation of R. S. Carlin, Inc. in the area near Snow Shoe, Pa. are described. Details are also presented of the economic contribution the company makes to the community. Reclaimed areas are backfilled and planted with trees and game-food shrubs. R312

R63-18 A VOLUNTARY INDUSTRY PROGRAM FOR MINED-LAND CONSERVATION

Sullivan, G. D., Proc. Ill. Mining Inst., Ann. Meet., Oct. 18, 1963. pp 85-94. In this overall review of the surface mining industry and its progress, the author points out that a small segment of the operators have brought criticism to the industry as a whole. He itemizes the growth of Reclamation Associations and gives statistics to show significant voluntary efforts by the coal

R63-18 (continued)

industry. Legislation is discussed, including recommendations made by various Commissions. The Mined-Land Conservation Conference is described and a list of their recommendations is included. Local or state regulations are cited as most practical, however the author feels that a significant voluntary effort is under way and this effort in cooperation with government agencies can do the necessary job. R480

### R63-19 SURFACE MINE LAND CONSERVATION

Am. Mining Congr. Ann. Convention, Pittsburgh, Pa., May 8, 1963. This booklet contains several papers: "A new approach to strip land reclamation" by Larry Cook; an address by Arnold E. Lamm; "Land conservation in Pennsylvania" by W. G. Jones; and a presentation to the American Bar Association by G. Don Sullivan. These speeches discuss the laws, the strip-mining industry, reclamation procedures and the socio-economic effects of surface mining. R290

### R63-20 HYBRID POPLAR GROWS POORLY ON ACID SPOIL BANKS AT HIGH ELEVATIONS IN WEST VIRGINIA

Trimble, G. R., Jr. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-7 (1963). 4 pp. The Northeastern Station started this program in 1951-52 on acid spoil banks from strip mining in Northern West Virginia at an elevation of about 3,500 ft. The spoils were compacted and were made up of sandstone, shale and large amounts of coal and rock fragments. Plantings were made on limed and unlimed plots. Survival and growth on unlimed blocks were poor, averaging 20 percent after three seasons. Although lime treatment had a favorable effect it was concluded that hybrid poplars should not be planted on sites with difficult growing conditions. R76

## 1964

### R64-1 EVALUATION OF PLANTS USED IN VEGETATING STRIP-MINE SPOIL IN THE LONESOME PINE SOIL CONSERVATION DISTRICT OF VIRGINIA

Augustine, M. T., Vaden, J. H., and Baker, C. D., U.S. Dept. Agr., Soil Conservation Serv. January 1964. 18 pp. About 50 varieties or strains of grasses, legumes, ground covers, shrubs, and trees were evaluated in field trials. A number have made good to excellent growth without added fertilizer or mulch on seemingly barren waste lands. pH of spoils varied from 4.5 to 7.7. R191

### R64-2 GEOLOGICAL DESCRIPTION AND EFFECTS OF STRIP MINING ON COAL OVERBURDEN MATERIAL

Brant, R. A. (Ohio Geol. Surv.), Ohio J. Sci. 64, 68-75 (1964). The geology of the coal regions in Ohio is described and related to physical and chemical changes that affect overburden material in strip-mine spoil banks. In partic-

R64-2 (continued)

ular, pyrite is noted as being most concentrated in coal and in layers immediately above coal so the recommendation is made to segregate and bury layers of high pyrite content. R176

R64-3 STUDY OF SPOIL BANKS ASSOCIATED WITH LIGNITE STRIP MINING IN NORTH DAKOTA: A REPORT PREPARED FOR THE THIRTY-NINTH LEGISLATIVE ASSEMBLY

Carlson, C. G. and Laird, W. M., North Dakota Geol. Surv., Misc. Ser. 24 (1964). 28 pp. This study was conducted to determine the extent and condition of spoil piles from previous strip-mining operations, to determine current operations and reclamation practices, and to make recommendations for future operations. It was generally agreed that these spoil banks would support plant life but further revegetation research was urged. Wildlife habitat was one of the land uses recommended. R350

R64-4 CONSERVATION AND LAND USE IN THE SURFACE COAL MINE INDUSTRY

Mined Land Conservation Conference 10/5/64. This booklet contains several speeches given at the Conference of Surface Mining in Roanoke, Virginia, April 13-14, 1964: "Surface mining - minerals, metals and divots," by Julian W. Friss; "Some pertinent Water Resources Division studies in acid mine drainage problems by U.S. Geological Survey," by Arnold E. Lamm; "The Open Cut Land Reclamation Act in Illinois," by E. E. Filer; a statement by George F. Deasy to the Subcommittee on Minerals, Materials and Fuels relative to S.1013; "The New Land," by Paul N. Seastrom, and a presentation by G. Don Sullivan to the American Bar Association. These speeches discussed laws, enforcement, history of strip mining, and current reclamation. R291

R64-5 SECOND-YEAR RESULTS OF HYBRID POPLAR TEST PLANTINGS ON BITUMINOUS STRIP-MINE SPOILS IN PENNSYLVANIA

Davis, G. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-19 (1964). 7 pp. This publication summarizes the survival and height growth of 60 clones after two growing seasons. The paper gives soil characteristics of the six plots that were used and the plantings in each. Planting methods and results are discussed and the results are tabulated. Acidity was found to be the most important single factor relating to survival and height growth, since "height growth and survival generally increased as pH increased." R171

R64-6 COAL STRIP MINE RECLAMATION, PART 2 - RECENT LEGISLATION

Deasy, G. F. and Griess, P. R., Mechanization 28 (1), 23-5 (1964). This article reviews the development and institution of reclamation laws by the various states. These laws were considered relatively modest in demands. The trend is now toward much more stringent requirements. The authors specu-

R64-6 (continued)

late about what the Federal government might do about long abandoned mining areas which need correction. The problem of expense (taxpayers' money) is a big consideration, whether to completely reclaim or do some marginal work, enough to remove the major damages and unsightliness. Another angle is to leave the great number of sites in their present condition. The whole tone of this article seems to be in a question form relative to what the governmental agencies should either do themselves or require local agencies to have done. R253

R64-7 THE STRIP-MINE PROGRAM IN OHIO

Dickman, I. I. (Ohio Div. Reclamation), Ohio J. Sci. 64, 165-8 (1964). The development of legislation controlling strip mining in Ohio is reviewed. R176

R64-8 FIRST PULPWOOD HARVEST FROM SPOILBANK "NEW FORESTS"

Pa. Conservation Assoc., News Release, Oct. 6, 1964. Five photographs, with captions, show the first pulpwood delivered to the Tyrone Mill of the West Virginia Pulp & Paper Co. from a reforested spoil bank area. R586

R64-9 FLEXIBLE MOUNTAINTOP SURFACE MINING

Coal Age 69 (4), 118-121 (1964). This article describes the problems of mountain-top surface mining as practiced by the Caperton Coal Co., Hazard, Ky. This company has gone beyond backfilling and seeding of mined areas in the steep mountains and has found that apple trees thrive in the type of soil found at a number of eastern Kentucky mines. Surface-mining companies in eastern Kentucky are now making available about 1000 acres/yr of leveled land for development into apple orchards. Pictures show the planting areas and a sketch shows how Caperton backfills and levels land for orchard development. R313

R64-10 GUIDES TO EFFICIENT STRIP MINING - DRAINAGE, RECLAMATION

Coal Age 69 (7), 220-21 (1964). This comprehensive article discusses all phases of strip mining including a section on drainage and one on reclamation. In drainage, use of gravity, efficient pumping and eliminating inflow to the mine are important. A discussion on low cost mine-water neutralization is also included. R317

R64-11 THE RELATION OF WATER TO STRIP-MINE OPERATION

Hanna, G. P., Jr. (Ohio State Univ., Water Resour. Cent.), Ohio J. Sci. 64, 120-4 (1964). The study of Beaver Creek Basin (R62-5) is used to illustrate the effects of strip mining on hydrology and to point out the importance of

R64-11 (continued)

water handling to control pollution. R176

R64-12 STRIP MINE SPOIL RECLAMATION

Heddleson, M. R., Farrand, E. P., and Ruble, R. W., The Penn. State Univ. College of Agr., Extension Serv. (undated). 14 pp. This illustrated booklet discusses problems, legislation, planning of reclamation, and characteristics of soil and spoil banks. Careful study and evaluating of any area is necessary to determine what future use is most suitable to its condition. R187

R64-13 ANNOTATED BIBLIOGRAPHY ON SLOPE STABILITY OF STRIP MINE SPOIL BANKS

Hoffman, G. J., Curry, R. B., and Schwab, G. O., Ohio Agr. Expt. Sta., Res. Circ. 130 (1964). 92 pp. This compilation of 366 references is arranged alphabetically by author and has a subject index. 64-16

R64-14 HISTORY OF DEVELOPMENT OF STRIP MINING MACHINES

Hollingsworth, J. A., Jr., Bucyrus-Erie Company (undated). 16 pp. This bulletin traces the development of strip mining equipment to its present level. Walking draglines and large shovels now handle great amounts of overburden and can place it far enough away from the strip mine to minimize refuse pile problems. R202

R64-15 COLLINS MINING COMPANY - CONSERVATIONISTS

Hunt, J. W., Mechanization 28 (1), 12-16 (1964). The Collins Mining Company of Hanging Rock, Ohio has become a large strip mining operation. Raw coal is processed at their preparation plant. A detailed account of the coal mining and handling operations, including land reclamation, is given. R252

R64-16 SOME PRESENT DAY RECLAMATION PROBLEMS: AN INDUSTRIALIST'S VIEWPOINT

Hyslop, J. (Consolidation Coal Co.), Ohio J. Sci. 64, 157-65 (1964). The author discusses objections to filling the last cut of a strip mine and to stockpiling topsoil. He compares characteristics of Ohio and German strip mining. R183

R64-17 STRIP MINING IN EASTERN OHIO: BLESSING OR CURSE?

Hyslop, J., Presented to Rotary Club, St. Clairsville, Ohio, May 18, 1964. 13 pp.+ The aesthetic, land use, and monetary effects of strip mining are discussed in detail for the purpose of refuting arguments for abolishing strip mining. R353

### R64-18 FROM WASTE TO PROFITS

Jones, D. C., Coal Mining Process. 1 (7), 20-22 (1964). Wallick Coal, Inc. of Strasburg, Ohio has been able to recover limestone, clay, and shale as profitable side products to its coal business. The company now has a Limestone Division. Clay goes into brick making and the shale goes into sewer pipe. Limestone is prepared and used on state roads, in cement blocks, and ready-mixed concrete. Details of each operation are given and tonnages obtained are significant. Their surface mined area is reforested with locust, pine, maple, and sycamore seedlings. Some of the reclaimed area is used for pasture. R218

### R64-19 METHODS AND RESULTS OF STRIP-MINE RECLAMATION IN GERMANY

Knabe, W. (Fed. Res. Organization Forestry, Forest Products, Germany), Ohio J. Sci. 64, 75-105 (1964). The historical development and current status of strip mining in Germany is reviewed. Questions and discussion of the paper are also included. R176

### R64-20 A VISITING SCIENTIST: OBSERVATIONS AND RECOMMENDATIONS CONCERNING STRIP-MINE RECLAMATION IN OHIO

Knabe, W., Ohio J. Sci. 64, 132-157 (1964). This general review article stresses planning reclamation as part of the mining operation. Problems of revegetation, especially forestation, are discussed. Some comparisons are made with German experience. R176

### R64-21 SPOIL BANK GOES FROM WASTE TO FODDER

Krause, R. R. (Ohio Power Co.), Reprinted from Coal Mining Process., May 1964. 4 pp. In the Ohio Power Co. project to develop pasture land from mined banks, research was carried out to determine species of grasses and legumes best adapted to the type of spoil, the best fertilization and seeding practices, and the optimum method of management for maximum meat production. Tabulated data give soil constituents and certain fertilizer components. An original soil study was made in 1953 and samples have been analyzed at 2-year intervals since then. R508

### R64-22 SURFACE MINE RECLAMATIONS -- WHY AND HOW

Lamm, A. E. (Pittsburg & Midway Coal Mining Co.), Reprinted from Mining Congr. J., March, 1964. 6 pp. This reprint gives considerable statistics on the strip mining industry and shows a number of pictures on reclamation. Safety of surface mining is stressed and reference is made to the good reclamation job done by the industry. A section discusses a TVA Report which answers industry critics. Industry supports the Enforcement of Reclamation laws which should be the responsibility of local agencies. The formation of the Mined Land Conservation Conference is discussed and their program is outlined. R280

### R64-23 LET'S TALK ABOUT TOMORROW

Reprinted from Consol News 3 (4) (1964). 6 pp. In Hanna Coal Company's reclamation program, their reclaimed lands have been used for residential building, timbering, pasture land, recreation areas, lakes, and fruit orchards. R223

### R64-24 REVEGETATION OF OHIO'S STRIP-MINED LAND

Limstrom, G. A. (Central States Forest Expt. Sta., U.S. Dept. Agr.), Ohio J. Sci. 64, 112-119 (1964). The objectives of this paper are to show what conditions appear to be important in accurate site appraisal for the reclamation of strip-mined land in Ohio and, should a decision be made to revegetate a strip-mined area to trees, what planting plans should be made. (From text) R176

### R64-25 SURFACE MINE RECLAMATION: CONTINUING RESEARCH CHALLENGE

May, R. F., Coal Age 69 (3), 98-99, 101 (1964). Forest Service Central States Forest Experiment Station objectives were to protect forest areas during mining and to learn how disturbed areas could be restored within practical economic bounds. They set out to find out how to grow timber, establish wildlife and fish habitats and to provide forest recreational opportunities. The Forest Service has a record of more than 25 years of reforestation research in the Appalachian and Eastern Interior provinces. R314

### R64-26 COMPARATIVE LIMNOLOGY OF STRIP-MINE LAKES

Parsons, J. D. (Southern Ill. Univ.), Verh. Internat. Verein. Limnol. 15, 293-298 (1964). Six strip-mine lakes in Missouri were characterized. Three were classified as Type I - Red Lakes, chemically the youngest, with high acid and iron content; and three were classified as Type III - Blue Lakes, which are chemically older and had low iron concentration, lacked turbidity and were homothermous year round. These six lakes were compared to Type II Lakes, transitional between Types I and III, and to Type IV Lakes, chemically the oldest, with least iron and acidity and measurable alkalinity. 64-88

### R64-27 PULPWOOD HARVESTED FROM SPOIL BANK FORESTS

Coal Age 69 (11), 26 (1964). Reclaimed spoil material supplied pulp wood for the first time for the paper industry from original planting done in Cooper Twp. of Clearfield County in 1950. The wood was delivered in 1964 to the West Virginia Pulp and Paper Company mill at Tyrone, Pennsylvania. The trees were red and white pine, Norway spruce, and Douglas fir. The program was initiated by the Pennsylvania Conservation Association. R315

### R64-28 RECLAMATION IN INDIANA

Coal Age 69 (7), 44 (1964). The Indiana Coal Association has planted more than 1.2 million pines and native hardwoods in 1964. Over 60,000 acres have been reforested of the slightly more than 80,000 acres which have been disturbed since surface mining first began. Another 6700 acres have been seeded making a total of 67,000 acres reclaimed to date (1964). All reclamation is carried out under the supervision of the Indiana State Dept. of Conservation and under the general direction of the Indiana Coal Association and at the expense of each individual coal company. Jour

### R64-29 RECREATIONAL ACTIVITIES ON ILLINOIS STRIP-MINED LAND

Roseberry, J. L. and Klimstra, W. D., Reprinted from J. Soil Water Conserv. 19 (3) (1964). 4 pp. More than 4,000 acres of land are being excavated annually for open-pit mining in Illinois. A portion of the resulting spoil areas might well be developed to meet increasing needs for recreational space contend the authors of this article. Herein they detail the current use of the more than 108,000 acres of strip mined land in the state and they describe the recreational use now being made of stripped areas. (Synopsis of article) R224

### R64-30 STRIP-MINE RECLAMATION: A DIGEST

Schessler, T. E. (Mining Valuation Eng.), Eastern Region, Forest Serv., U.S. Dept. Agr., Revised 1964. 69 pp. This revision brings up-to-date the summary of strip-mine legislation and includes several new references. R577a

### R64-31 FUTURE LAND USE IN THE APPALACHIAN PLATEAU AND ITS RELATION TO STRIP-MINE RECLAMATION

Sitterley, J. H. (Ohio Agr. Expt. Sta.), Ohio J. Sci. 64, 106-111 (1964). In projecting land use in 1980 of the Ohio Segment of the Appalachian Plateau, the author predicts that "any change that is likely to occur in the relationship between land use and the reclamation of strip-mined land will arise more from the need for watershed protection, pollution control, and recreation than from a need for agriculture." The economic and sociological reasons for this conclusion are presented. R176

### R64-32 CLASSIFICATION AND REVEGETATING OF STRIP-MINE SPOIL BANKS

Smith, H. G., Morse, H. H., Bernath, G. E., Gillogly, L. E., and Briggs, W. M. (Soil Conservation Serv., USDA), Ohio J. Sci. 64, 168-175 (1964). This paper discusses: classification of strip mine spoils for purposes of determining suitable land use, conditions for plantings, and observational plantings and practices employed by the U.S. Soil Conservation Service in strip mine reclamation. (From authors' text) R176

### R64-33 SURFACE MINING'S CONSERVATION PROGRAM PAYS OFF

Stearn, E. W., Reprinted from Coal Mining Process., April 1964. The Mined Land Conservation Conference was formed in 1965 to encourage sound reclamation programs. Examples are given of research in several states including the Ayreshire and Pittsburg and Midway Coal companies successful farming activities. R523

### R64-34 CHEMICAL WEATHERING OF STRIP-MINE SPOILS

Struthers, P. H. (Ohio Agr. Expt. Sta.), Ohio J. Sci. 64, 125-131 (1964). Amounts of salts leached from strip-mine spoils were determined in lysimeter studies. Among the observations are: weathering improves toxicity; and soluble mineral plant nutrients were generally more abundant in spoils than in Ohio soils. R176

### R64-35 SURFACE MINING - EXTENT AND ECONOMIC IMPORTANCE, IMPACT ON NATURAL RESOURCES, AND PROPOSALS FOR RECLAMATION OF MINED-LANDS

Proc. Conf. Surface Mining, Roanoke, Va., by Council State Gov. (Apr. 13-14, 1964). 64 pp. Surface mining for coal is one of the concerns of this meeting. Complete speeches, excerpts from talks and records of a panel discussion and a synopsis of replies to a roll-call of the 15 states involved are recorded. R209

### R64-36 GUIDE FOR CLASSIFYING AND REVEGETATING STRIP MINE SPOIL IN KENTUCKY

Taff, H. A., U.S. Dept. Agr., Soil Conservation Ser. Lexington, Ky., 1964. 16 pp.+ Vegetation species are recommended for all classes of spoils: acid, alkaline, and toxic. Also, the report covers use of strip-mine spoil for hay and pasture, wildlife, recreation, and woodlands. A map of Kentucky shows the counties and the strip-mining operations. R39

### R64-37 TOURIST RECREATION RESOURCES IN SOUTHERN INDIANA

Dept. Recreation Park Admin., Ind. Univ., for U.S. Dept. Comm., Area Redevelop. Admin., Oct. 1964. pp 129-140. This excerpt pertaining only to Planning District #1 is an itemized list of public recreational facilities in southern Indiana. Seven of these locations were strip-mine areas which had been reclaimed for recreational purposes. R211

### R64-38 WHAT ABOUT STRIP MINING?

Mined Land Conservation Conference, 1964. 16 pp. This illustrated brochure of reclamation shows lakes developed from stripping operations, cattle herds, game lands, forest developments and agricultural products from farms on previously coal stripped areas. R289

R64-39 WHY SURFACE MINES?

Consol News 3 (4), 1-15 (1964). Several articles in this issue cover Hanna Coal Co.'s reclamation program, the use of crownvetch in revegetation, and activities of Ohio Reclamation Association. R441

R64-40 BENEFICIAL USES OF STRIP MINE SPOIL IN THE LONESOME PINE SOIL CONSERVATION DISTRICT OF VIRGINIA

U.S. Department of Agriculture, Soil Conservation Service (undated). (4 pp). Vegetation on mined lands in the area is described. Also, urban, industrial, and recreational uses of the mined lands are illustrated. R922

R64-41 CONSERVATION AND LAND USE IN THE SURFACE COAL MINE INDUSTRY

Mined-Land Conservation Conference, Oct. 5, 1964. (59 pp). This compilation of papers and speeches presented at various meetings includes general reviews of surface mining and reclamation; a description of the reclamation program carried out by the United Electric Coal Companies in Illinois, under the title "New Land," presented by P. N. Seastrom; and "The Open Cut Land Reclamation Act in Illinois," presented by E. E. Filer. R827

R64-42 STRIP COAL MINE RECLAMATION PROBLEMS IN INDIANA

Guernsey, L. (Indiana State University), Indiana Academy of Science Proceedings 74, 255-258 (1964). Spoil acidity, water pollution, grading, revegetation, land use, and legal problems are discussed. R944

R64-43 COAL FOR TODAY - TIMBER FOR TOMORROW

Jones, W. G., Reprinted from The Northern Logger, June 1964. 4 pp. The author describes the cooperative effort carried out by the U.S. Forest Service. the Pennsylvania Department of Forests and Waters, and the Pennsylvania State University with the Pennsylvania Conservation Association, an organization of bituminous coal producers, to reforest surface-mined land. R828

R64-44 LAND OF THE PURPLE FLOWER; LET'S TALK ABOUT TOMORROW; OHIO RECLAMATION ASSOCIATION REPRESENTING OHIO SURFACE MINING OPERATORS

Consol News 3 (4), 6-15 (Fourth Quarter, 1964). These articles describe the use of crownvetch, "the purple flower," the uses of reclaimed land of Hanna Coal Company, and the work of the Ohio Reclamation Association. R829

## 1965

### R65-1 RESEARCH AND DEMONSTRATION PROJECTS IN THE ABATEMENT OF ACID MINE DRAINAGE

Buscavage, J. J. (Pa. Dept. Health), Proc. 20th Ind. Waste Conf., Purdue Univ., 1965. pp 664-72. This article reviews the history of the mine drainage problem and summarizes work done on the major projects sponsored by the Mine Drainage Section of the Department of Health. These projects are Monongahela River Mine Drainage Remedial Project, El Campton Strip Mine Reclamation Project, Wetmore Coal Study, Retreat Mining-Christopher Coal Co., Toms Run Project, Slippery Rock Creek Survey. Also noted are the following Coal Research Board Projects in the Department of Mines: Buttonwood overflow study, Butler water tunnel study, flow augmentation study, Watershed Reclamation Demonstration Project. An estimated 254 million dollars would be needed to make substantial progress toward elimination of this problem over a 10 year period. R30

### R65-2 CHRISTOPHER'S GOOD NEIGHBOR POLICY

Reprinted from Consol News 4 (4) (July-August 1965). This is a short account of a combined project of Christopher Coal Co. and the Soil Conservation Service. About 340 strip mined acres were bought by Christopher and revegetated by tree planting following SCS plans. R547

### R65-3 COAL AND STRIP MINING RECLAMATION

Exploring Kentucky 2 (1), 24 (1965). This very short article on the coal activity from its beginning in Kentucky notes that recently much more coal is being strip mined, and that although reclamation was criticized for a long time, it is generally agreed the state has a good reclamation law now. R222

### R65-4 COLORADO LEGISLATIVE COUNCIL COMMITTEE ON STRIP MINING

Committee brochure, (undated). (14 pp). This booklet gives some history of strip mining in Colorado and points to the fact that Colorado had the first voluntary agreement with respect to reclamation entered into by any state. During the year the agreement was signed (1965) 621 acres of Colorado were reclaimed by coal companies. Pictures show the success of the reclamation. Work done at each of four mining operations is summarized. Coal companies involved were Peabody Coal Co., Energy Coal Co., and Pittsburg & Midway Coal Mining Co. R198

### R65-5 SUMMARY OF FACTS. RUNOFF FROM CAST OVERBURDENS FORMED BY SURFACE MINING OF COAL, PIKE COUNTY, INDIANA, FALL, 1964

Corbett, D. M., Indiana Univ. Water Resour. Res. Cent. with Ayshire Collieries Corp. and Enos Mining Div., Interlake Iron Co. June, 1965. 10 pp.

R65-5 (continued)

This project covered 270 square miles of the Patoka River watershed extending from Flat Creek near Velpen to the mouth of the South Fork Patoka River near Oakland City. The findings presented in the formal report (See R65-6) are summarized here. R288

R65-6 WATER SUPPLIED BY COAL SURFACE MINES, PIKE COUNTY INDIANA

Corbett, D. M., Water Resour. Res. Center, Indiana Univ., Rept. Invest. No. 1, 1965. 67 pp.+ The conclusion from this study is that low flow contribution from cast-overburden is significant. Stream flow readings were taken at more than 150 sites on four occasions between September 16 and November 16, 1964, the driest fall on record. Water quality was not measured. 65-79

R65-7 CHEMICAL AND PHYSICAL PROPERTIES OF SPOIL BANKS IN THE EASTERN KENTUCKY COAL FIELDS

Cummins, D. G., Plass, W. T., and Gentry, C. E., U.S. Forest Serv. Res. Paper CS-17 (1965). 11 pp. Ten spoil samples from six major coal-producing seams were analyzed. They showed medium to extreme acidity with generally low concentrations of total soluble salts and organic matter. Exchangeable calcium was low to very low on all spoils and magnesium was abundant; which imbalance may adversely influence plant growth. Available potassium and phosphorus were present in amounts low to adequate for growth. Concentrations of available iron, manganese, aluminum and sulfur probably toxic to many plants were common on extremely acid spoils. (Adapted from text) R203

R65-8 THEY'RE MINING FOR BASS IN KANSAS

Dalrymple, B. W., True's Fishing Yearbook No. 16, 52-4 and 93-95 (1965). The author relates his fishing experience in Kansas waters which a few years earlier were strip-mine pits. The article describes the physical details of the acreage and the fishing advantages. R130

R65-9 RECLAIMING STRIP-MINED LANDS IN NORTH DAKOTA BY ESTABLISHING GAME MANAGEMENT AREAS

Gwynn, T. A., Knife River Coal Mining Company, Bismack, N.D., Jan. 1, 1965. 36 pp.+ This report outlines the lignite strip-mining activity in North Dakota where the best use of strip-mined land will be for wildlife, recreation or grazing. The work reported here was done by the Knife River Coal Mining Company cooperating with the various state and federal agencies. The cost of leveling spoil banks is in proportion to their heights. A number of pictures show some of the results and the strip-mining operation. R144

R65-10 FAUZIO FAMILY PUTS LIFE INTO PANTHER VALLEY

Hunt, J. W., Coal Mining Process. 2 (6), 36-41 (1965). The Greenwood Stripping Corp. is surface mining anthracite coal east of the Little Schuylkill River in the Southern Anthracite Field. The operation from deep haulage pits is described. R35

R65-11 MINED AREA RESTORATION OF TOMORROW

Jemison, G. M., J. Soil Water Conservation 20 (4), 186-8 (1965). This article forecasts the condition which may exist 35 years hence when coal usage will be 2-1/2 times what it is now. The author predicts revegetation problems will be solved by the year 2000 and restored mined areas will become valuable suburban centers. R37

R65-12 STRIP MINING IN KENTUCKY

Montgomery, R. and Camplin, P. (Ky. Dept. of Natural Resour.), The Strip Mining and Reclamation Commission, 1965. 56 pp. In this complete history and study of the strip-mining problem in Kentucky, many pictures show the progress of mining and the results of reclamation efforts. Information is included on coal deposits in the United States as well as on the geology of the Kentucky coal fields. The economics of both strip and deep mining are discussed, and considerable space is devoted to reclamation--its background, the regulations, the program, the function of the Kentucky Strip Mining and Reclamation Commission, and the hydrology of strip mined areas. R142

R65-13 PENNSYLVANIA'S LAND RECLAMATION ACT

Mining Engineering 17 (7), 145-6 (1965). The Conservation Act adopted by Pennsylvania in January of 1964 regulated the restoration of open pit coal mines. In the first twelve months of the act, 1300 acres had been restored. The article describes the strip-mining operation of Krach and Gearheart of Luthersburg. This company began reclamation before passage of the act. R519

R65-14 PROPOSED OUTLINE OF REPORT REQUIRED ON STRIP AND SURFACE MINING IN THE UNITED STATES AS AUTHORIZED UNDER P.L. 89-4, SECTION 205 OF THE APPALACHIAN REGIONAL DEVELOPMENT ACT OF 1965

U.S. Dept. Int., Off. Assist. Sec.--Miner. Resour., April 1965. 55 pp.+ This report contains all proposed items on strip and surface mining to be covered under a study authorized by Section 205(c) of Public Law 89-4 89th Congress. In addition to the study, the Secretary of the Interior is authorized under Section 205(a) to conduct an active program of surface-mine rehabilitation on publicly-owned land in the Appalachian region as well as subsidence and mine fire projects. The extent of strip and surface-mined areas are outlined by states, and the reclamation work is discussed in the light of Federal, state and private interests in relation to their responsibilities

R65-14 (continued)

and share of the costs. R34

## R65-15 RECLAIMED STRIP LANDS TO PRODUCE ELDERBERRIES

Coal Age 70 (3), 29 (1965). J. M. Smucker Co., Orrville, Ohio, will use elderberries from plants purchased by Hanna Coal Co. to plant on 20 acres of reclaimed strip-mined lands adjacent to their mining operations in Cadiz, Ohio. R468

## R65-16 MIRACLE OF SPOIL BANKS--A NEW BEAUTY AND A NEW INDUSTRY

Rickard, D., The Philadelphia Inquirer Magazine, March 28, 1965. The Pennsylvania Conservation Association has planted 150,000,000 trees on Central Pennsylvania strip-mined lands. The growth rate was abnormally good so the association planted 10,000 trees each year. First commercial cutting of these trees was expected after about 6 years. R520

## R65-17 DRESS UP TIME FOR THE STRIP MINES

Straub, F., Cincinnati Pictorial Enquirer, 8-14, August 29, 1965. This pictorial account of strip-mining activity is complete with many pictures of reclaimed areas and lakes converted to good fishing sites. R38

## R65-18 STRIP AND AUGER MINING IN KENTUCKY

Ky. Dept. Natural Resour., Frankfort, Ky.(undated). This small folder gives facts and figures and a brief history of strip and auger mining. It also lists provisions of the 1964 Law and describes administration of the stripmine law regulations. R262

## R65-19 STRIP MINING HEALS ITS OWN SCARS

Business Week, Nov. 13, 1965. 3 pp. The growth of the strip-mine industry and attendant legislative control and reclamation costs are discussed. R584

## R65-20 ADVANCES IN STRIPMINE RECLAMATION

Struthers, P. H. and Vimmerstedt, J. P., Reprinted from Ohio Rept. 50 (1), (1965). 2 pp. The knowledge gained from 15 years of research on growth of forage crops and trees on strip-mined land is reviewed. R168

R65-21 RAPID STRIPMINE RECLAMATION

Struthers, P. H. and Vimmerstedt, J. P., Reprinted from Ohio Rept. 50 (6), (1965). 2 pp. Rain percolation and weathering of coal mine spoil material is important to leach out soluble salts. A high gypsum content reduces moisture for plant growth. Shaping the ground for greater rain retention is a key factor in both weathering and vegetative development. Acid mine drainage results from leaching toxic salts from spoil and should be treated separately to prevent stream pollution. R170

R65-22 COAL'S CONTRIBUTION TO A BETTER AMERICA: MINED LAND CONSERVATION

Sullivan, G. D., Coal Mining Process. 2 (6), 28-31 (1965). Industry and government reclamation programs, including the development of both agricultural and recreational lands, are described. R104

R65-23 WATER STORAGE POTENTIAL OF SURFACE MINED COAL LANDS

Truax, C. N., Jr., Reprinted from Mining Congr. J., Nov. 1965. 4 pp. This article explains how strip-mine cast overburden serves as a valuable water reservoir in dry periods. Indiana University scientists made a study of this condition and found that during dry periods, creeks in unmined areas were dry whereas this was not the case in the mined sections. The study was made in southwestern Indiana, an area which suffers from chronic floods and droughts. R212

R65-24 MINED AREA RESTORATION TODAY

VanLandingham, A. H. (W. Va. Univ.), J. Soil and Water Conservation 20 (4), 185-6 (1965). Mining methods, rehabilitation after mining, research on strip-mine spoil, use of reclaimed areas, and factors affecting reclamation are discussed. The Soil Conservation Service develops a revegetation plan for each permit submitted after the grading is completed. The most striking difficulty in dealing with spoil areas is the extreme variation in physical and chemical characteristics which exist on such areas. These characteristics differ from area to area, bank to bank and from spot to spot in the same bank. R36

R65-25 VARIED USES OF SURFACE MINE SPOIL IN WEST VIRGINIA

W. Va. State Soil Conserv. Comm., (undated). This illustrated folder shows examples of the uses of reclaimed areas, including farms, forests, and church and school buildings. R354

R65-26 STRIP MINING: KENTUCKY BEGINS TO CLOSE THE RECLAMATION GAP

Walsh, J., Science 150, 36-39 (Oct. 1, 1965). Strip-mining operations and the problems of reclamation in Kentucky mountains are discussed, as well as the

R65-26 (continued)

Kentucky strip mine and reclamation law passed in 1964. R582

R65-27 THE WAY TO NEW LAND USES

Mined-Land Conservation Conf., (undated). 8 pp. Reclamation of strip-mined lands is illustrated. R436

R65-28 DESIGNING COAL-HAUL ROADS FOR GOOD DRAINAGE

Weigle, W. K., USDA, Central States Forest Expt. Sta., 1965. 23 pp. This article concerns proper methods of controlling drainage for the purpose of maintaining good coal-haul roads. Road designs with drainage culverts and ditches are shown. Recommendations for check dams are included. R15

R65-29 WHAT'S AHEAD FOR SURFACE MINING

Coal Mining Process. 2 (6), 18-21, 41 (1965). Among the developments expected in surface mining over 10 years are a 23 percent increase in production operations of 180 yd shovels and 120 yd draglines, and improvements in blasting. R35

R65-30 HOOSIER COAL

Indiana Coal Association (undated). (15 pp). The history and economic importance of coal mining in Indiana are reviewed, and the reclamation efforts of the coal companies are described and pictured. R823

R65-31 STRIP MINE RECLAMATION RESEARCH - WHERE ARE WE?

May, R. F. (U.S. Forest Service), Mining Congr. J. 51 (4), 52-55 (1965). Reclamation research programs in Kentucky and Ohio are reviewed. R818

R65-32 PIKE COUNTY INDIANA FISHING - HUNTING - CAMPING PATOKA STATE FISH AND GAME AREA

Indiana Coal Association and Enos Coal Corporation (undated). (2 pp). This flyer gives information on sporting and recreation activities on reclaimed mined land in the county. R825

R65-33 RESOURCEFULNESS IN RECLAMATION

The Marion Groundhog, Summer, 1965. pp 9-11. Published by Marion Power Shovel Company, Marion, Ohio. Pictures show mined land in Indiana, Illinois,

R65-33 (continued)

and Ohio reclaimed to farming and a recreational area. R967

R65-34 S.E.K.O.R.E.A. AREA MAP

Southeast Kansas Outdoor Recreation Association (undated). This large map of the southeast corner of Kansas shows the location of recreational facilities including the many strip-pit lakes that have been developed for fishing. R838

R65-35 A NEW SCIENCE -- MINED LAND RECLAMATION

Sullivan, G. D. (Mined-Land Conservation Conf., NCA), Mining Eng. 17 (7), 142-144 (1965). This article describes a voluntary industry program, the Mined-Land Conservation Conference, to expand reclamation. The author reviews efforts of reclamation which began in 1918, and discusses planning for reclamation. R581, Jour

## 1966

R66-1 STRIP MINING, RECLAMATION AND THE PUBLIC INTEREST

Brooks, D. B. (Resources for the Future, Inc.), Reprinted from American Forests, March, 1966. 4 pp. In this general description of strip mining and reclamation, advantages of strip mining are emphasized and the increase in total stripped coal over the years is noted. Benefit-cost analysis as related both to mining and to reclamation is discussed. R129

R66-2 ANTHRACITE MINING SPOILS AS MEDIA FOR PLANT GROWTH

Cornwell, S. M., Ph.D. Thesis, Cornell Univ., 1966. 187 pp. University Microfilms, Inc. 67-1455. The study was done in the anthracite region of Pennsylvania. The spoil materials are divided into 5 classifications each of which is described. Spoil and vegetation analyses and field and greenhouse trials were used to examine and characterize the spoils. Separate chapters cover nutrient status, vegetation survey, grey birch studies, mining spoils as media for plant growth and conservation perspectives. Since availability of different minerals differs in different spoil types, the author concludes that "the evidence presented indicates that the field classification based upon rock type is an adequate system for assessing spoils as media for plant growth. Consideration of basic mineralogy and weathering processes in the spoils appears to be a more satisfactory basis for their classification than simple criteria such as pH and texture. In particular, the ratio between basic and acid-producing materials is of primary importance in determining the final properties of the spoils." R228

### R66-3 SURVIVAL AND EARLY GROWTH OF PLANTED FOREST TREES ON STRIP-MINE SPOILS IN THE ANTHRACITE REGION

Czapowskyj, M. M. and McQuilkin, W. E. (Northeastern Forest Expt. Sta., Upper Darby, Pa.), U.S. Forest Service Res. Paper NE-46, 1966. 29 pp. This is the second of several reports dealing with mine-spoil revegetation research in the anthracite region of Pennsylvania. In 1962 a survey type study was conducted to evaluate the performance of forest tree species in established plantings on strip-mine spoils. Plantations representing a wide range of site conditions in all four anthracite fields were examined. Seven years was selected as the standard plantation age for most of the sampling. Extensive tabulated data are included on the spoil types and progress of the selected plantings. Numerous pictures show the circumstances of several older areas. Overall average survival of all species was adequate, i.e., 40-60 percent, provided no disturbance had occurred after planting. No extensive conditions that would preclude tree growth were observed. R23

### R66-4 CONTROL OF WATER AT STRIP MINING OPERATIONS THROUGH SOUND MINING

Deane, J. A. (Peabody Coal Co.), Proc. 21st Ind. Waste Conf., Purdue Univ., 1966. pp 1-3. Water control at strip mine operations has two separate parts. The first is handling waste from the cleaning plant; the second is handling the water at the active pit. Settling ponds will handle the waste slurry and usually the clear overflow is returned to the plant. Refuse piles are a problem and must be covered and planted. Siltation is one of the greatest potential pollutants from strip mining, especially where land is graded to long slopes. R31

### R66-5 FLEXIBILITY ENHANCES RESULTS IN TWO-SEAM SURFACE MINING

Reprinted from Coal Age, January 1966. 7 pp. Adventure Coal Co. and its subcontractor Black Raven Coal Co. in Eastern Kentucky recover coal from tracts previously considered too isolated for economical mining. A number of pictures show the stripping and auger equipment which has produced more than $1 million annual business for this rugged mountain area. Reclamation was started in 1959 and grasses and 20 ft trees have covered the area in only 5 years. The planting and seeding is handled by the Kentucky Reclamation Association which tests the soil before planting. The company also pays the Reclamation Association as much as 2¢ per ton of coal mined for planting and sowing grasses. R131

### R66-6 EFFECTIVE RECLAMATION SETS STAGE FOR INDUSTRIAL DEVELOPMENT

Flowers, A. E., Coal Age 71 (12), 66-70 (1966). The 22-year reclamation program of Harmon Creek Coal Corp., Burgettstown, Pa., includes a modern industrial plant, swimming pool, community park, private lake, model plane airport, new high school, revegetated area, and a company nursery. R443

### R66-7 DEMONSTRATION AND EVALUATION OF FIVE METHODS OF SECONDARY BACKFILLING OF STRIP-MINE AREAS

Griffith, F. E., Magnuson, M. O., and Kimball, R. L., U.S. Bur. Mines, RI 6772 (1966). 17 pp. Cost data are given for five methods of secondary backfilling of strip mines previously partially backfilled. The operations were conducted in north central Pennsylvania; an average of 600 linear feet of highwall were backfilled in each trial. Major obstacles and the relative merits of the methods are discussed. (Authors' abstract) R207

### R66-8 RECLAIMING STRIP-MINED LAND BY ESTABLISHING GAME MANAGEMENT AREAS-A PROGRESS REPORT

Gwynn, T. A. (Knife River Coal Mining Co.), Knife River Coal Mining Co., July 15, 1966. (27 pp.) The status of the reclamation plantings of trees, grasses and forage crops on several strip-mined areas is reported. One area has the problem of alkaline soil. Wildlife moving into the area was doing some damage to the trees, although willows seemed to be spreading enough to give extensive browsing for deer. (See R65-9) R188

### R66-9 REVEGETATION OF STRIP-MINED AREAS IN SOUTHWESTERN WYOMING

Lujan, L. E., M. S. Thesis, Univ. Wy., 1966. 82 pp. A survey of an area which Kemmerer Coal Company had strip mined included soil sampling, rainfall and temperature records, and a cursory evaluation of vegetation. Among factors making Wyoming spoil banks difficult to revegetate are low pH and high aluminum, accumulation of soluble salts because of poor drainage, lack of moisture, and high winds in exposed areas. Eight hundred trees were planted and their survival and growth recorded. Russian olive was found to be best adapted to conditions of the study area. Most favorable sites were northeastern and eastern top slopes. R360

### R66-10 REMARKS BY STATE CONSERVATIONIST

McKeever, I., Pennsylvania Coal Mining Assoc. Ann. Meet., Bedford Springs Hotel, Bedford, Pa., Sept. 22, 1966. The speaker gave some figures on bituminous strip-mined land and the acreage which has been revegetated. There is still a significant area which is ungraded and is bare or sparsely covered with vegetation. The speaker gave the number of different species which have been tested and noted that the Soil Conservation Service has trained personnel who can provide capable help to operators with reclamation problems. R522

### R66-11 RESULTS OF REVEGETATION OF STRIP MINE SPOIL BY SOIL CONSERVATION DISTRICTS IN WEST VIRGINIA

Mellinger, R. H., Glover, F. W., Jr., and Hall, J. G., W. Va. Univ., Agr. Expt. Sta. Bull. 540, Dec. 1966. 18 pp. Both successful revegetation of strip-mine spoil and some of the problems are illustrated in this brochure. R60

R66-12 LAND DISTURBANCES FROM STRIP-MINING IN EASTERN KENTUCKY
1. UPPER CUMBERLAND COAL RESERVE DISTRICT

Plass, W. T. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-52 (1966). 7 pp. This publication describes the extent of strip mining in eastern Kentucky and tabulates the strip-mined areas. Included is a section on the physical characteristics of the disturbed areas. A record of coal haulage roads was prepared so it is possible to calculate the acres of mine disturbance per mile of road. The district average was found to be 98 acres/mile of road. (See R67-4 - R67-8) R147

R66-13 MINED-LAND CONSERVATION, STATE AND NATION

Published by NCA Mined-Land Conservation Conference monthly or bimonthly from 1965 to 1972. This series gives examples of reclamation projects by the coal industry and reports other news about reclamation. R505

R66-14 A SECOND LOOK AT SURFACE MINING

Rankin, B., Consol News 5 (1), 2-7 (1966). This article describes the reclamation work done in Ohio by Dr. Riley of Kent State, Rod Krause, then with Ohio Power Co., and Art Wallace of Hanna Coal Co. Pictures show reclaimed areas including picnic facilities, good fishing lakes, pastures and forest lands. R418

R66-15 RESTORING LAND TO PRODUCTIVE USE

Reprinted from 84th Annual Report, Ohio Agr. Res. & Develop. Cent. (1966). 1 p. Site improvement can be accomplished by grading to promote maximum retention of rainfall and by proper planting. Orchard grass, trefoil and bluegrass are noted as having proven best for quick and eventually dense ground cover. R77

R66-16 THE STRIPPERS/EXPERIMENTS BY COAL OPERATORS IN REHABILITATION

Sawyer, L. E., Reprinted from Landscape Architecture, January, 1966. 4 pp. This article reviews the background of strip mining and discusses the need for reclamation and new ways to handle overburden. The author cites cooperation with the Central States Forest Experiment Station and outlines some of the things they learned about revegetation. In Indiana there is a great demand for reclaimed land for recreational use and some of the lakes are providing the best fishing in the state. R281

R66-17 STRIP COAL MINING---THE TOTAL-BENEFIT INDUSTRY

Coal Age 71 (4), 93-116 (1966). This article reviews methods of reclamation and the various uses of reclaimed land. R110

R66-18 STRIP MINE LAND RENEWED

Hi-Lines (Ill. Power Co.), Jan. 1966. pp 4-7. The reclamation work done in Illinois by Southwestern Illinois Coal Corp. is described and pictured. Areas have been developed for farm lands and for recreation. R417

R66-19 STUDY OF STRIP AND SURFACE MINING IN APPALACHIA

Interim Rept. from Secretary of the Interior to Appalachian Regional Comm., 1966. 78 pp. This report is made in compliance with the requirement of the Appalachian Regional Development Act of 1965. Effects of coal mining are emphasized both because the largest areas stripped are for coal and because inadequate data was found on mining for other commodities. Mining methods, reclamation methods and effectiveness, costs, and land use are discussed. Appendix II is a comparison of strip-mining laws in effect at the time of the report in the states in the Appalachian region. R172

R66-20 SURVEY SURFACE-MINED AREAS

Consol News 5 (2), 13-15 (1966). This article describes several reclamation programs in West Virginia and includes several pictures of reclamation results. R442

R66-21 SPOIL BANK STABILITY IN EASTERN KENTUCKY

Weigle, W. K. (U.S. Forest Serv.), Reprinted from Mining Congr. J., April, 1966. 3 pp. Seventeen slides in four counties of eastern Kentucky were studied. The stability of each slope was computed using the method of slices. The article explains how slides develop and progress. The use of controlled fill bench widths created stable banks. Use of practices developed in this project can minimize disturbances to watersheds. R156

R66-22 COAL STRIP MINING IN TENNESSEE

Zarger, T. G. (TVA), Reprinted from KTG Journal 6 (3) (1966). 3 pp. This short article describes the beginning of strip-mining operations in Tennessee. Up to 1964, approximately 30,000 acres had been affected in 16 counties in Tennessee. The problems of stream pollution, wasted land productivity, legislation and reclamation are discussed briefly. R279

R66-23 STRIP MINE RECLAMATION AND ECONOMIC ANALYSIS

Brooks, D. B., (Resources for the Future, Inc.), Natural Resources J. 6 (1), 13-44 (1966). If the primary purpose of this paper is to emphasize the applicability of economic analysis to strip and auger mining, its secondary purpose is to indicate the lack of appropriate data and to stimulate the collection of it. (From author's Conclusion) R800

R66-24 PROPERTIES AND PLANTABILITY OF EAST KENTUCKY SPOIL BANKS

Cummins, D. G., Plass, W. T., and Gentry, C. E., Coal Age 71 (11), 82-85 (1966). Physical and chemical properties were determined for ten spoil samples collected at six mining sites. The analyses show that most of the spoils will support plant life, but it must be mainly vegetation that will tolerate acidity, high concentrations of iron, manganese, aluminum, and sulfur, and low calcium. 66-62 Jour

R66-25 KENTUCKY LEADS THE NATION IN RECLAMATION

Kentucky Department of Natural Resources, Division of Reclamation (undated). (2 pp). This pamphlet includes several colored pictures of reclamation projects in the state. R824

R66-26 STATEMENT OF INDIANA COAL ASSOCIATION BEFORE STUDY COMMITTEE ON SURFACE MINING AND RECLAMATION

Sawyer, L. E., Petersburg, Indiana, Sept. 19, 1966. 4 pp. The legislative requirements in effect in Indiana at the time of this presentation are reviewed. Reclamation programs and research by the coal industry in the state are summarized. R798

R66-27 STRIP MINING BUILDS FOR ACCELERATED GROWTH

Coal Age 71 (8), 113-136 (1966). The history of strip mining and the development of mining equipment to the currently used giant machines is described in some detail. Reclamation history is also reviewed, and the various uses of reclaimed land are pointed out. Advice is given on publicizing the reclamation programs of the coal industry to counter the adverse public image of surface mining. Jour

R66-28 STATUS OF RECLAMATION OF COAL STRIP MINED LAND IN ILLINOIS: PAST AND PRESENT PLUS A FORECAST OF THE FUTURE

Weber, L. S. (Mid-West Coal Producers Institute, Inc.), Illinois Federation of Sportsmen's Clubs, Annual Meeting, Springfield, Illinois, March 26, 1966. 12 pp. The author describes the history of surface mining and reclamation as background to his comments on the requirements of the Illinois Open Cut Reclamation Act which became effective on January 1, 1962. He also comments on the value of strip-mine lakes for recreational fishing. R968

## 1967

R67-1 BLIGHT ON THE LAND

Bauer, E. A. and East, B., Outdoor Life, pp 35-37, 123-28, December 1967. This article is well illustrated with pictures of areas in Ohio, West Virginia

R67-1 (continued)

and Kentucky. Considerable space is devoted to mine water accumulations which have ruined a number of fishing spots. Many statistics are given on areas which have been disturbed and considerable comment is made on the degree of damage done by strip mining. The development of large strip mining equipment is discussed and the methods of handling overburden. R286

R67-2 RECLAIMING STRIP-MINED LAND BY ESTABLISHING GAME MANAGEMENT AREAS

Gwynn, T. A. (Knife River Coal Mining Co., N. D.), Index '67, Regina, Saskatchewan, Canada, Aug. 27-Sept. 2, 1967. 14 pp. The author talks about the lignite mining industry in North Dakota and the need for reclamation. He gives some figures on the fuel needs for power generation. He refers to Consolidation Coal Company's lignite gasification plant at Rapid City. The author refers to reclamation in other parts of the country and explains what his Conservation Association has done. He emphasizes that reclamation is an individual problem with each company and should be carefully studied to get maximum results. R287

R67-3 OVERBURDEN AND BANK ACIDITY EASTERN KENTUCKY STRIP MINES

May, R. F. and Berg, W. A. (Northeastern Forest Expt. Sta., Berea, Ky.), Reprinted from Coal Age, June 1967. 2 pp. Ten high wall sections were sampled to determine pH values of several coal seam overburden deposits in Kentucky strip mines. The seams selected were upper breathitt, upper middle breathitt, lower middle breathitt and lower breathitt. The acidity distribution in the overburden over the five Kentucky seams shows that most of the potentially acid material lies immediately over the coal seam or in the partings within the seam. For backfill, it is suggested that a ridge of non-toxic material should be saved at the edge of the bank. 67-201

R67-4 LAND DISTURBANCES FROM STRIP-MINING IN EASTERN KENTUCKY
2. PRINCESS COAL RESERVE DISTRICT

Plass, W. T. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-55 (1967). 8 pp. This publication describes the extent of strip mining in eastern Kentucky and tabulates the strip-mined areas. Included is a section on the physical characteristics of the disturbed areas. A record of coal haulage roads was prepared so it is possible to calculate the acres of mine disturbance per mile of road. The district average was found to be 65.8 acres/mile of road. (See R66-12) R148

R67-5 LAND DISTURBANCES FROM STRIP-MINING IN EASTERN KENTUCKY
3. LICKING RIVER COAL RESERVE DISTRICT

Plass, W. T. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-68 (1967). 6 pp. This publication describes the extent of strip mining in eastern Kentucky and tabulates the strip mined areas. Included is a section on the physical characteristics of the disturbed areas. A record of

R67-5 (continued)

coal haulage roads was prepared so it is possible to calculate the acres of mine disturbance per mile of road. The district average was found to be 47 acres/mile of road. R149

R67-6 LAND DISTURBANCES FROM STRIP-MINING IN EASTERN KENTUCKY
4. BIG SANDY COAL RESERVE DISTRICT

Plass, W. T. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-69 (1967). 7 pp. This publication describes the extent of strip mining in eastern Kentucky and tabulates the strip-mined areas. Included is a section on the physical characteristics of the disturbed areas. A record of coal haulage roads was prepared so it is possible to calculate the acres of mine disturbance per mile of road. The district average was found to be 121 acres/mile of road. R150

R67-7 LAND DISTURBANCES FROM STRIP-MINING IN EASTERN KENTUCKY
5. HAZARD COAL RESERVE DISTRICT

Plass, W. T. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-71 (1967). 7 pp. This publication describes the extent of strip mining in eastern Kentucky and tabulates the strip-mined areas. Included is a section on the physical characteristics of the disturbed areas. A record of coal haulage roads was prepared so it is possible to calculate the acres of mine disturbance per mile of road. The district average was found to be 107 acres/mile of road. R151

R67-8 LAND DISTURBANCES FROM STRIP-MINING IN EASTERN KENTUCKY
6. SOUTHWESTERN COAL RESERVE DISTRICT

Plass, W. T. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-72 (1967). 8 pp. This publication describes the extent of strip-mining in eastern Kentucky and tabulates the strip-mined areas. Included is a section on the physical characteristics of the disturbed areas. A record of coal haulage roads was prepared so it is possible to calculate the acres of mine disturbance per mile of road. This district average was found to be 66 acres/mile of road. R152

R67-9 PULPWOOD PRODUCTION POTENTIAL ON STRIP-MINED LAND IN THE SOUTH

Plass, W. T. and Burton, J. D. (U.S. Forest Serv.), Reprinted from J. Soil Water Conserv. 22 (6) (1967). 4 pp. Experimental work conducted by the Forest Service in Alabama, Tennessee, and Kentucky indicated that growth of pine trees on spoil areas will not be as fast as on good pine sites, but it may equal or exceed the growth on eroded, abandoned or similar areas that have shallow soils. In site evaluations of strip-mined areas, pH is a reliable indicator of plantability. Spoils of pH 4.0 or lower generally will not support good enough tree growth for pulpwood production. R153

### R67-10 CAMPSITES FROM SCARRED LAND

Rankin, B., Reprinted from Better Camping, November-December 1967. pp 20-22. This reprint describes two reclamation projects. One is that of Ohio Power Company which now has 250 lakes and 20 million trees in its total program on 30,000 acres. The other is a 150-acre tract of strip-mined land bought by Dr. Charles Riley now of Kent State, who made this area into a beautiful farm where he now lives. R292

### R67-11 THE STRIP MINING OF BITUMINOUS COAL IN PENNSYLVANIA

Pa. Coal Mining Assoc., (undated). 20 pp. This booklet is an overview of Pennsylvania strip mining including several illustrations. R610

### R67-12 CURRENT RESEARCH TRENDS IN MINED-LAND CONSERVATION AND UTILIZATION

Sullivan, G. D., Mining Eng. 19 (3), 63-67 (1967). This account of reclamation projects includes activities of TVA, Indiana Coal Association, Central States Forest Experiment Station, Purdue University, Kansas State Forestry, Fish and Game Commission, West Virginia Surface Mining & Reclamation Association, and ORSANCO. R125

### R67-13 THREE STRIP-MINED AREAS--

Mining Congr. J. 53 (10), 12 (1967). Three strip-mined areas totaling nearly 50 acres at Greater Pittsburgh Airport will be restored to provide a smooth contour in a new federal-state cooperative project. All three of the old-coal-stripping sites now owned by the county are in line or near the western approach to the major east-west jet runway at the airport. Pits will be backfilled and spoil piles will be graded, rolled, and seeded. R214

### R67-14 EFFECTS OF SPOIL GRADING ON TREE GROWTH

Chapman, A. G., Mining Congr. J. 53 (8), 93-100 (1967). The results of experimental plantings established in 1946 and 1947 in Illinois, Missouri, and Kansas were surveyed after 19 and 20 growing seasons. Plantings established at the same time in Ohio were surveyed after 10 growing seasons. The height, survival, and growth of the trees were generally greater on ungraded than on graded spoil. Smooth grading to premining contour, the type discussed in the article, of spoils containing more than 15 percent clay may cause soil compaction. Some of the results of compaction are loss of pore space for air and water movement in tree root zones, reduction of water infiltration causing more runoff and erosion, slower weathering of acid spoils, lower availability of minerals essential for tree growth, and a lack of soil biota. Jour

### R67-15 SELECTED EFFECTS OF GLACIAL TILL ON THE PHYSICAL CHARACTERISTICS AND EXISTING LAND USE OF INDIANA'S STRIP MINED LANDS

Guernsey, L. (Indiana State University), Indiana Academy of Science Proceedings 77, 305-311 (1967). The evaluation and analysis of samples from

R67-15 (continued)

22 selected mined areas show that generally with a higher percentage of glacial till spoil is less acid, contains more fine-textured material, and there is an improvement in the quality and intensity of the use of reclaimed lands. R942

R67-16 OPERATION GREEN EARTH

Peabody Coal Company, St. Louis, Missouri, two brochures. 1963, 10 pp. March 1967, 12 pp. These brochures describe and illustrate Peabody Coal Company's reclamation activities. R837

R67-17 SURFACE MINED LAND RECLAMATION

Sawyer, L. E. (Midwest Coal Producers Institute), Proceedings University of Minnesota Mining Symposium, Duluth, Minnesota, Jan. 28, 1967. pp 79-83. This paper reviews the history of mining reclamation in Indiana and gives status at the time of this presentation. Normally about 50 percent of the mined areas can be revegetated the year following mining. Over 80 percent of the acreage disturbed by mining has been reclaimed, including nine rather large lakes used for recreation and fishing. Lakefront property has been developed as camp-sites or as desirable year-round residential sites. R754

## 1968

R68-1 EFFECTS OF SURFACE MINING ON FISH AND WILDLIFE IN APPALACHIA

Boccardy, J. A. and Spaulding, W. M., Jr., Bur. Sport Fisheries Wildlife, Resour. Publ. 65 (1968). 20 pp. This report on the effects of strip and surface mining on the fish and wildlife resources in eight Appalachian states is based in part on observations made during a tour of strip and surface-mined areas by authors as members of a team of specialists from six federal agencies. Three of the eight states visited in 1965-66 had no laws requiring restoration of strip-mined lands. (From authors' abstract) R45

R68-2 BENEFIT - COST ANALYSIS OF SURFACE MINING FOR COAL: RESEARCH METHODS AND RESEARCH NEEDS

Brock, S. M. (W. Va. Univ.), AIME Fall Meet., Minneapolis, Minn., Sept. 18, 1968. 13 pp. Preprint No. 68-K-355. This paper discussed strip and auger mining costs and uses data obtained from the Myles Job Mine in northern West Virginia. Included in the cost data were estimates of reclamation costs and mine drainage neutralization using lime. The methodology used in the study is described, and some of the findings on the utility of cost-benefit analysis are summarized. 68-211

### R68-3 THE MYLES JOB MINE - A STUDY OF BENEFITS AND COSTS OF SURFACE MINING FOR COAL IN NORTHERN WEST VIRGINIA

Brock, S. M. and Brooks, D. B., W. Va. Univ., Appalachian Cent., Off. Res. Dev., Res. Ser. 1, 1968. 61 pp. This is a detailed cost study of all items pertaining to mining, acid drainage and reclamation for the Myles Job Mine which produced 47,000 tons of coal--a rather small operation. Very detailed descriptions are given on acid control and spoil bank material handling and revegetation. The cost analysis is tabulated in two appendixes. 68-210

### R68-4 AVAILABILITY OF NITROGEN TO PLANTS IN ACID COAL MINE SPOILS

Cornwell, S. M. and Stone, E. L., Nature 217, 768-9 (1968). This short article contains results of a nitrogen study made on acid mine spoils to learn its effect on plant growth. Analytical work was done on spoils in the anthracite region and nitrogen contents are tabulated. The tree growth on the spoil material was examined with the idea of correlating growth to the available nitrogen in the various spoil fractions. Liberation of fixed ammonium was determined to be a definite influence in vegetation on spoil surfaces. Behavior of other compounds is also discussed. A deficiency of nitrogen is recognized as a limiting factor to growth on mine spoils. R540

### R68-5 COAL-MINE SPOIL BANKS OFFER GOOD POTENTIAL FOR TIMBER AND WILDLIFE PRODUCTION

Davis, G. and Davidson, W. H., Reprinted from Pennsylvania Forests, Winter-Spring, 1968. 2 pp. Editorial article explains the producing potential of strip-mined areas. Although most spoil sites will produce timber products, only about one quarter can be classed as good, and about one quarter are too poor to produce timber. Conifers do especially well on spoil banks. Valuable hardwoods such as cherry, walnut, yellow poplar, and sugar maple do not grow well on Pennsylvania spoil banks. Most promising hardwood is hybrid poplar. Reclamation can be designed specifically for wildlife production. R19

### R68-6 REVEGETATION STUDIES ON COAL SPOIL BANKS

Jacoby, P. W., Jr., M. S. Thesis, Univ. Wy., 1968. 51 pp. Crested wheatgrass, intermediate wheatgrass, smooth brome grass and alsike clover were studied to determine which adapted best to spoil bank conditions. The use of jute net, mulch, snowfence, irrigation, and combinations of these were evaluated for their benefit to establishment of vegetation. Treatments were nonreplicated on spoil banks three, nine, and fifteen years old to determine the best age of spoil bank weathering to initiate seeding. Moisture, mulch, and erosion prevention were found to be necessary for plant establishment. R362

R68-7 PROBLEMS OF SOIL MECHANICS IN OPENCAST MINING. PART 2: TIP STABILITY TESTS

Kézdi, A., Bergbautechnik 8, 398 (1968). National Coal Board, Trans. A. 2758/HSA. The problem of stability in waste heaps depends on the density of the tipped material and the change in density through the pile, pore-air pressure and water pressure, and conditions of strata underlying the heap. A set of formulas is included for calculating various characteristics of tips and a number of diagrams show slip planes, subsidence, compression curve, settling, and construction methods of preventing subsidence. R217

R68-8 REVEGETATION STUDIES AT THREE STRIP-MINE SITES IN NORTH-CENTRAL PENNSYLVANIA

Magnuson, M. O. and Kimball, R. L., U.S. Bur. Mines RI 7075 (1968). 8 pp. As part of an experiment in the restoration of lands strip-mined for coal, revegetation studies were conducted at three backfilled strip-mine sites in north-central Pennsylvania. The sites were subdivided into plots that were given varying amounts of lime and fertilizer. In tests conducted cooperatively with state and federal agronomy experts the plots were then planted with a variety of trees, shrubs and grass-legume mixtures. Initial tree and shrub survival was not appreciably affected by lime and fertilizer applications where the spoil pH was above 4.5. Of fourteen species of trees and shrubs tested, Norway spruce, black locust, Japanese larch, pitch pine and white pine were the hardiest. The ground-cover percentage of grass-legume mixtures in the second growing season was substantially increased by using lime and fertilizer. Mixtures comprised partly of fescue were the most satisfactory. (Authors' abstract) R165

R68-9 A LANDSCAPE ARCHITECTURAL APPROACH TO RECLAMATION AND DEVELOPMENT OF DEEP ANTHRACITE STRIP PITS

Miller, E. L. and DeTuerk, J. R. (Dept. Landscape Architecture), The Pa. State Univ. Spec. Res. Rept. SR-68 to Pa. Coal Res. Bd. (1968). 28 pp. Characteristics of mined areas are analyzed and used as the basis for plans to develop and beautify three strip pit areas. 662.6 P4

R68-10 OHIO POWER RECREATION AREA: PUBLIC FISHING MAP

Ohio Dept. Natl. Resour. Div. Wildlife, Publ. NRW-205 (2nd Rev. June 1968). Ohio Power Company opened its reclaimed strip-mined land to public camping and fishing. The strip-mine ponds are stocked by the state. R629

R68-11 OHIO RECLAMATION ASSOCIATION IN THE NEWS

O. Reclam. Assoc., 1968. 4 pp. This group of news items on mine land reclamation appeared in various Ohio newspapers in the first half of 1968. R457

## R68-12 TREE SURVIVAL AND GROWTH ON FESCUE-COVERED SPOIL BANKS

Plass, W. T. (Northeastern Forest Expt. Sta., Berea, Ky.), U.S. Forest Service Res. Note NE-90 (1968). 4 pp. In this study we tried to determine how an established fescue cover affects tree survival and growth. We found the ground cover did not affect survival but did reduce the height growth of sycamore and sweetgum. It had little effect on growth of white pine and loblolly pine. (From author's abstract) R17

## R68-13 A SALUTE TO THE PENNSYLVANIA COAL MINING ASSOCIATION

Pennsylvania Forests 58 (1), 3-28 (1968). The main emphasis of the several articles in this issue is the use of reforestation in the reclamation of stripped areas. The problem of covering the acid spoil associated with bituminous deposits is an important consideration. R132

## R68-14 MATCH ADDITIVE TO SOIL TYPES FOR BEST STABILIZATION

Weigle, W. K. and Williams, G. P., Jr. (U.S. Dept. Agr.), Reprinted from Rural & Urban Roads, June, 1968. 2 pp. A number of chemical additives including lime were used to stabilize roads and soils. Spoil material was also used in this test program. A record of compressive strengths is listed for many of the test samples. The three best additives were asphalt, sealing oil, and mixing oil. All bitumens waterproof and dustproof soil in addition to acting as a binder. R157

## R68-15 MANGANESE TOXICITY OF LEGUMES SEEDED IN KENTUCKY STRIP-MINE SPOILS

Berg, W. A. and Vogel, W. G., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service Research Paper NE-119 (1968). 12 pp. The occurrence of manganese toxicity was studied on six legume speies grown in 46 different acid strip-mine spoils from Kentucky. This toxicity was characterized by a distinct paling (chlorosis) on the leaf margins that was readily seen on young leaves of all the species except Kobe lespedeza. Spoil pH was useful in predicting Mn toxicity on these legumes; water-soluble Mn extracted from the spoils was not. (For. Ser. Abs.) R772

## R68-16 AN ECONOMIC APPRAISAL OF RECLAMATION PRACTICES ON A STRIP COAL MINE SITE IN GREENE COUNTY, INDIANA

Dinkel, R. M. and Guernsey, L. (Indiana State University), Indiana Academy of Science Proceedings 78, 355-361 (1968). Plantings of six species of trees and of two grasses were made on sandstone and on very acid shale. Some of the area to be planted was treated with fungal culture filtrates and some was used as control. Survival rates of the plantings were reported as being "not outstanding." Costs of revegetation and of soil treatment are discussed. R952

## 1969

### R69-1 CHEMICAL, MINERALOGICAL AND PHYSICAL PROPERTIES OF EASTERN KENTUCKY ACID-FORMING COAL SPOIL MATERIALS

Barnhisel, R. I. and Massey, H. F., Soil Sci. 108 (5), 367-372 (1969). Spoil bank materials were sampled at three locations in Eastern Kentucky. A total of seven samples are described and an extensive analysis was run on them after a specific preparation. The chemical results are tabulated as well as physical data. Detailed procedures are included for sample handling and the mineralogical data are given in tabulated form. All seven samples were mixtures of mica, illite, Kaolinite and quartz. The samples were extremely acid and toxic, posing serious problems of plant cover. The chemical and physical properties of the two coal beds involved were distinctly different. Chemical treatment of these banks would be needed to insure adequate plant cover. R333

### R69-2 DETERMINING pH OF STRIP-MINE SPOILS

Berg, W. A. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-98 (1969). 7 pp. Comparison of several methods of determining pH of spoils shows that the LaMotte-Morgan method and a modification of it gave the least deviation from values determined by a pH meter. Suggestions are made for adequate sampling of spoils. R74

### R69-3 ON THE PROBABLE ENVIRONMENTAL EFFECTS OF COAL MINING AND COMBUSTION IN WESTERN CANADA

Berkowitz, N., Research Council of Alberta - Research Contribution No. 449. Presented 21st Canadian Conference on Coal, Calgary, Alberta, Sept. 10-11, 1969. 12 pp. Policy in Western Canada takes for granted that the mined site should not be inferior to premining conditions. Upon consideration of effects of strip mining, the author concludes that successful reclamation is possible. R66

### R69-4 BIG MUSKIE: KING OF THE GIANTS

Coal Age 74 (12), 50-61 (1969). At the Central Ohio Coal Company's Muskingum Mine, the dragline removes overburden in 220 cu yd bites. The large equipment was developed to remove more than 100 ft of overburden. The entire mining operation, including other mining machinery and coal handling, is described. It is noted that the large mining machinery will reduce reclamation costs. R108

### R69-5 THE ECONOMICS OF MINED LAND RECLAMATION

Brooks, D. B. (U.S. Bur. Mines), Proc. Mining Environ. Conf., Rolla, Mo., by Ext. Div., and Dept. Mining Petrol. Eng., Univ. Mo., Apr. 16-18, 1969.

R69-5 (continued)

pp 85-98. This discussion of the economics of reclamation emphasizes the role of government as a major influence and the importance of cost-benefit analysis in dealing with pollution and its effects. 622 M61

### R69-6 CANADIAN GEESE TRANSPLANTED IN ILLINOIS

Coal Mining Process. 6 (9), 33 (1969). Forty-four birds of a giant variety of Canadian goose have been released in Illinois on the property of United Electric Coal Company to establish a nesting flock. The property is a 30,000 acre reclaimed strip mine area near Canton, Illinois. R127

### R69-7 ANTHRACITE COAL-MINE SPOILS TODAY--FORESTS TOMORROW

Czapowskyj, M. M., Pa. Forest 59 (3), 81-83 (1969). This article describes the efforts of the forest service Northeast Experiment Station at Kingston, Pa. to reclaim the large strip-mined acreage of northeastern Pennsylvania. Total disturbance in the anthracite region was measured as 112,000 acres, 76 percent from strip-mining. Crown vetch and various grasses were used for quick temporary cover. Trees planted were Jack, red, Scotch and pitch pines. Hardwoods survived better than the conifers. Hybrid poplars showed great potential in strip-mine spoil. Results proved anthracite strip-mine spoil types can support planted trees. Graded sites gave better results than ungraded areas. R25

### R69-8 DEVELOPING BIG-SCALE RECLAMATION SYSTEMS

Coal Mining Process. 6 (3), 40-42 (1969). This article points out the need for development of larger reclaiming machinery to keep up with the capacity of overburden removal machines. Three diagrams illustrate how to use the box-cut method to minimize dozing and dragline work in reclamation. Pictures of draglines with special buckets show how to handle extra volumes of spoil material with this equipment. R126

### R69-9 FRIENDSHIP PARK HAS POTENTIAL TO BECOME RECREATION MECCA ON RECLAIMED LAND

Consol News 8 (5), 14-16 (1969). The planned development of Friendship Park, Jefferson County, Ohio, is described. The land was donated to the county by Hanna Division, Consolidation Coal Co. 69-102

### R69-10 OPERATION GREEN EARTH

Grandt, A. (Peabody Coal Co.), Proc. Mining Environ. Conf., Rolla, Mo., by Ext. Div., and Dept. Mining Petrol. Eng., Univ. Mo., Apr. 16-18, 1969. pp 76-83. The Peabody Coal Co. has planted almost 32 million trees in the 13

R69-10 (continued)

years before 1968. A table gives their planting and seeding record covering eight states. The author discusses in detail grading, pasture and range land, hay and crop land, timber and forest land and recreational use. The company has built five dams. A number of towns and villages now have good water supplies as a result of surface mining. Both winter and summer sports are available in the recreation areas. 622 M61

R69-11 AN IMPROVED ENVIRONMENT THROUGH INTELLIGENT MINED-LAND RECLAMATION

Gwynn, T. A. (Knife River Coal Mining Company), AIME Fall Meet., Salt Lake City, Utah, Sept. 17-19, 1969. Preprint No. 69-F-343. 31 pp. The author discusses the reclamation problem generally in the first part of his paper and then discusses the extent of reclamation in the Northern Rockies and the Great Plains States and the specific details of North Dakota, Montana and Wyoming reclamation laws. He discusses in detail the stripping problems in the western states and shows how the reclamation approach differs from eastern practices. R474

R69-12 HANNA'S LAND RECLAMATION PROGRAM A MODEL FOR THE INDUSTRY

Consol News 8 (5), 1-11 (1969). Successful reclamation of strip-mined land and the variety of uses to which it can be put are described. 69-102

R69-13 CASE STUDIES OF SURFACE MINING

Hartman, H. L., Ed., Proceed. II International Surface Mining Conf., Minneapolis, Minn., Sept. 18-20, 1968, New York: AIME, 1969. 322 pp. The first section on coal mining covers surface mining in Australia, lignite strip mining in Germany, Ohio Central Coal Co. mine expansion program, the Captain mine in Illinois and open cast coal mining in the U.S.S.R. Each article explains the particular problem of waste disposal and the method of doing the work. Multiple use of mined land is discussed in the Ohio Coal Company's Mine Expansion Program. 622 H33

R69-14 REVEGETATION TREATMENTS FOR STAND ESTABLISHMENT ON COAL SPOIL BANKS

Jacoby, P. W., Jr. (Univ. Wyoming), J. Range Management 22, 94-97 (1969). Coal spoil banks near Kemmerer, Wyoming were subjected to several treatments designed to facilitate revegetation. These included the use of snowfence, jute net, and straw mulch applied to banks of three different ages. Evaluation by seedling density suggested that the older the spoil the more suitable for planting. All treatments produced seedling stands but a combination of jute netting and mulch gave best results. (Highlight) R564

R69-15 LAND RECLAMATION

Lamm, A. E. (Pittsburg & Midway Coal Mining Co.), Proc. Mining Environ. Conf., Rolla, Mo., by Ext. Div., and Dept. Mining Petrol. Eng., Univ. Mo., Apr. 16-18, 1969. pp 68-74. The author gives actual figures of coal disturbed land and compares them to land utilization for other purposes. The reclamation activities of coal industry associations are described. 622 M61

R69-16 RECLAMATION CREATES NEW RESOURCE

Coal Age 74 (12), 69-76 (1969). The reclamation program of Ohio Power Company began as far back as 1943 with tree planting. More recently, in cooperation with Ohio Department of Natural Resources, the company has developed reclaimed land as recreation areas, especially for fishing, camping, picnicking, and hunting. Reclamation, which closely follows mining, also includes reforestation and development of farm land. R109

R69-17 FUTURE OF MINING INDUSTRY RECLAMATION

Sawyer, L. E., Mining Congr. J. 55 (6), 50-54 (1969). Also presented at American Mining Congress Coal Convention, Pittsburgh, Pa., May 4-7, 1969. Paper 39. 9 pp. The background of the problem, the initial efforts, the industry program and the probable regulations which will face the mining people in the future are discussed. R467, 662.6 A665

R69-18 THE FUTURE OF MINING INDUSTRY RECLAMATION

Sawyer, L. E., Proc. Ill. Mining Inst., Ann. Meet., Oct. 9-10, 1969. pp 13-22. The history of strip-mine reclamation from planting fruit trees in 1918 through vegetation studies in the 1940's is reviewed. Reclamation accomplishments are noted and contrasted to the adverse picture of strip mining emphasized in the popular press. The prediction is made that there will be greater statutory regulation of mining and reclamation. 662 I29

R69-19 COVER ESTABLISHMENT ON STRIP-MINED AREA USING TWO RHIZOMATOUS GRASS SPECIES

Thompson, W. W., M. S. Thesis, Univ. Wy., 1969. 65 pp. Four study sites of different ages of strip mined overburden were chosen for revegetation studies to determine if western wheatgrass and inland saltgrass are adapted to vegetative establishment using sprigging and sodding techniques. Plantings were made at different times of the year; using both sprigging and sodding techniques; on different aged overburden piles; on top and east-facing slopes of piles; and behind and not behind snow fences. While the two grasses were used with varying success under the several test conditions, the two apparent most limiting factors influencing vegetative establishment are the amount of precipitation received before, during and after planting and moisture in the spoil material. (Adapted from Summary and Conclusions) R361

R69-20 TWO-STAGE STRIPPING

Reprinted from Coal Age, Jan. 1969. 6 pp. At Ayreshire Coal Company's Ayrcoe mine near Oakland City, Indiana, overburden removal runs 800,000 to 1,000,000 cu yds per month. Daily production averages better than 4000 tons and monthly tonnage is better than 70,000 tons. Flood lights are being installed to improve visibility for night loading. Capacity of loading facility is 3000 tph. R507

R69-21 WASTE DISPOSAL COSTS AT TWO COAL MINES IN KENTUCKY AND ALABAMA

White, D. H. and Danielson, V. A., U.S. Bur. Mines, IC 8406 (1969). 28 pp. This report gives the waste disposal costs of a Kentucky strip and underground coal mine and an Alabama coal mine. Both recently mined out areas and old strip pits are used for waste disposal and old strip pits are used for settling ponds at the Kentucky mine. All cost items are tabulated for each case and a cost per ton is calculated. R73

R69-22 SURFACE MINE RECLAMATION PROGRESSES IN INDIANA

Bakeis, W., Outdoor Indiana 34 (2), 35-38 (Mar. 1969). This review of reclamation practices in Indiana over the years lists different mixtures of tree species to be planted on various types of spoil. R914

R69-23 ACIDITY AND PLANT-AVAILABLE PHOSPHORUS IN STRATA OVERLYING COAL SEAMS

Berg, W. A. (1) and May, R. F. (2) [(1) Colorado State Univ. and (2) U.S. Forest Service], Mining Congr. J. 55 (3), 31-34 (1969). Each visibly different stratum of ten high wall sections approximately 0.1 mile apart was sampled at each of six Kentucky mines. Most of the extremely acid strata were rider or bone coal, recognizable by their black color. However, both acid and nonacid shales and sandstones were found in the same wide range of colors. Phosphorus levels were generally very low and the amount of overburden containing moderate (7-20 ppm) amounts was small. The study showed that neither phosphorus nor acidity occurred consistently from one highwall sampling section to another. R773

R69-24 BLACK DIAMONDS AND GREEN VISTAS

U.S. Department of Agriculture, Northeastern Forest Experiment Station, NE-INF-3-1969. 16 pp. This booklet gives a general description of the Forest Service research program on surface mine reclamation. R821

R69-25 GUIDE FOR CLASSIFYING AND REVEGETATING STRIP MINE AND OTHER SPOIL AREAS IN OHIO

U.S. Department of Agriculture, Soil Conservation Service, Columbus, Ohio, Jan. 1969. 15 pp. Spoil is defined by four categories containing several descriptive subclasses. The categories are Reaction, Texture, Stoniness, and Dominant Slope. The Guide also discusses vegetative establishment, land use alternatives, spoil handling and placement, and water and erosion control. There are tabulations of species of plants suitable for vegetation of spoils of various acidities. R907

R69-26 MINERALS, MINERAL PROCESSES AND THE QUALITY OF ENVIRONMENT

Sawyer, L. E., Natural Resources Public Policy Seminar, University of Washington, Seattle, Washington, 1969. 25 pp. The history of surface-mine reclamation in the Midwest is reviewed from its early beginnings in the 1920's. The development of mining laws and regulations is also traced. The author notes the sensational publicity given to adverse effects of mining and the seeming disregard by the media of successful reclamation. R1015

## 1970

R70-1 ANALYSIS: SURFACE MINE REGULATION

Brooks, D. B. (U.S. Bureau Mines), Coal Mining Process. 7 (3), 38-41 (1970). This article presents a study measuring the effects of Kentucky surface mine regulation on the output, employment and operation structure. The history of regulation in Kentucky is outlined and a series of graphs illustrates strip-mining production over the past 30 years. Conditions in East Kentucky are compared with those in West Kentucky. Auger mining is also very prevalent in Kentucky and the growth in this field has been significant. The rate of growth in all mining in Kentucky increased after 1960 in a period during stricter reclamation requirements. R138

R70-2 INFLUENCES OF STRIP MINING ON THE HYDROLOGIC ENVIRONMENT OF PARTS OF BEAVER CREEK BASIN, KENTUCKY, 1955-66

Collier, C. R., Pickering, R. J., Musser, J. J. (Editors), U.S. Geol. Surv. Prof. Paper 427-C (1970). 80 pp. In this third report in a series on the environmental effects of strip mining in McCreary County, Kentucky, Cane Branch, a stream acid from mining, is compared to Helton Branch which drains an unmined area. The paper includes separate studies on precipitation and runoff, ground water, water geochemistry, erosion and sedimentation, stream bottom fauna, fish population, microbiology of streams, and tree growth. The most obvious effects of strip mining were on the chemical composition of the water, sediment characteristics of the stream, aquatic biology, and on vegetation. The detailed data collected in the various studies are tabulated. R65

R70-3 COMPILED RESEARCH DATA ON RECLAMATION OF DISTURBED LANDS IN THE WESTERN UNITED STATES - 1970

Bur. Land Management, Denver Serv. Center, Symp. Mining Ecology in Arid Environ., Tucson, Ariz., March 22-27, 1970. (18 pp). This publication is an annotated bibliography of reclamation literature pertaining to western U. S. The list contains 41 articles which cover all phases of reclamation: spoil grading, erosion control, and all types of revegetation. It also contains a list and description of reclamation projects by states, including projects of five state highway departments. R3

R70-4 EXPERIMENTAL PLANTING OF 14 TREE SPECIES ON PENNSYLVANIA'S ANTHRACITE STRIP-MINE SPOILS

Czapowskyj, M. M. (Northeastern Forest Expt. Sta., Upper Darby, Pa.), USDA Forest Service Res. Paper NE-155, 1970. 18 pp. This is the fourth in a series of reports dealing with mine-spoil revegetation research in the anthracite region of Pennsylvania. A separate table lists the 14 species used. These were selected from many which had shown promise in earlier mine spoil plantings. Spoil types and progress made by each of the tree species is discussed. Physical and chemical characteristics of the sites are listed in separate tables. Pictures show the results produced by the best performing trees. Survival on graded spoil averaged almost twice as high as on ungraded spoils. Survival and height growth were recorded at the end of each growing season and evaluated over a 5-year period. R22

R70-5 DEER PREFER PINE SEEDLINGS GROWING NEAR BLACK LOCUST

Davidson, W. H. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-111 (1970). 4 pp. The presence of black locust seems to make some pine species on a bituminous coal spoil more palatable to white-tailed deer. Browse damage to some pine trees was significant, however proximity of black locust did not seem to strongly influence browsing of other pine species in the study area. (Author's abstract adapted) R128

R70-6 LAND RECLAMATION FOR THE MINING INDUSTRY

Falkie, T. V. and Saperstein, L. W. (Pa. State Univ.), Earth Miner. Sci. 40 (2), 9-12 (1970). Water control, and its effect on erosion, sedimentation and subsidence, toxic soil, high walls, spoil banks and waste disposal are all discussed. R145

R70-7 EFFECTS OF SURFACE MINING ON ENVIRONMENT

Gwynn, T. A. (Knife River Coal Mining Co.), Symp. Technol. Use of Lignite, Grand Forks, N. D., by U.S. Bur. Mines, Univ. N. D., May 1-2, 1969. 14 pp. U.S. Bur. Mines, IC 8471 (1970). pp 31-37. This general discussion of strip-mine reclamation problems in the Northwest reviews strip-mine legislation in

R70-7 (continued)

North Dakota, Montana, and Wyoming. R169

### R70-8 NEW METHODS IN MINED-LAND RECLAMATION

Krause, R. R., AIME Environ. Conserv. Session, St. Louis, Mo., Oct. 22, 1970. Preprint No. 70-F-354. 11 pp. This paper describes several methods of handling overburden and surface mining which give satisfactory reclamation results. The author also discusses water problems, acidity and the practices used by most reclaimers. A number of seeders and seeding methods are discussed. Use of prepackaged seedlings now is a popular revegetation technique. Two varieties of Bermuda grass appear to be most successful in West Virginia, and a Midland tall pasture sod forming variety has achieved a 100 percent cover in very low pH environment. R475

### R70-9 CURRENT RECLAMATION PROGRAMS IN THE WESTERN UNITED STATES

Loomis, T. H. W. (Denver Service Center, Bur. Land Management), Symp. Mining Ecology in Arid Environ., Tucson, Ariz., March 22-27, 1970. (8 pp). This paper was presented at the Symposium on Mining and Ecology in the Arid Environment, Tucson, Arizona, March 22-27, 1970. This paper is one from the Bureau of Land Management, Denver Service Center, Bldg. 50, Denver Federal Service, Denver, Colorado 80225. This agency has solo jurisdiction over all resources on 450 million acres of federal lands. In addition, they manage the mineral resources on another 350 million acres of federal lands and 62 million acres under public land laws as stockraising homesteads. The paper describes the operation of the Bureau and its land use policy. A number of slides were included in this paper but only their explanation is given. R4

### R70-10 SURFACE MINE RECLAMATION, MORAINE STATE PARK, PENNSYLVANIA

McNay, L. M., U.S. Bur. Mines, IC 8456 (1970). 28 pp. This report describes the methods used and cost data for surface-mined land reclamation in Moraine State Park, Butler County, Pennsylvania. A total of 177 acres of land was rehabilitated for specific land use purposes. The use of large equipment expedited the work. The restoration was conducted in two main areas, the North Central Section and the Northwestern Section. The hydrology of the area is described as well as the condition of the sites before reclamation. Details of site preparation, backfilling, terracing and a discussion of the results are included. Several grains and many varied pine trees were planted. Survival rate for the trees was 70-75 percent. Cost/acre was $800 in the North Central Section and $1,400/acre in the Central Section. R71

### R70-11 MINING COAL ON BLACK MESA

Peabody Coal Co., Nov. 1970. 12 pp. This booklet has been printed by the coal company to describe their mining operation at Black Mesa in Arizona.

R70-11 (continued)

Black Mesa is a highland used by Indians to graze sheep, goats and cattle. Native vegetation includes pinon, juniper, sagebrush and grass. The Indians are protected by the terms of the leases. Peabody guarantees to conduct a complete restoration program following closely behind the mining operation. A large map outlines the 64,858 acres leased by Peabody. R199

### R70-12 A BACKGROUND FOR DISTURBED LAND RECLAMATION AND RESEARCH IN THE ROCKY MOUNTAIN REGION OF ALBERTA

Peterson, E. B. and Etter, H. M., Canadian Forestry Service, Forest Res. Lab., Edmonton, Alberta, Inform. Rept. A-X-34 (May 1970). 45 pp. This publication is a review of the reclamation problem in the Rocky Mountain Region of Alberta, Canada. Potential land uses and reclamation planning are included with references to revegetation and choice of species. Reclamation controls are discussed as they relate to the local environmental conditions and as they affect mining costs. The major need in the Rocky Mountain area is a survey of all types of surface disturbances. It is recommended that this survey be done by the Alberta Department of Lands and Forests. An extensive list of references is furnished, together with a tabulation of reclamation costs. R275

### R70-13 RECLAMATION UNDER SEMIARID CONDITIONS

Coal Mining Process. 7 (11), 34-7 (1970). This story describes the problem of revegetation in Wyoming where rainfall is less than 20 inches/year. Coal seams are thick and the low sulfur keeps acid from forming. Land disturbance is minimal but revegetation is quite difficult. Topsoil is limited to 2 - 6 inches. Sprinkler systems are used periodically. Wyoming Game and Fish Dept. has aided in stocking lakes with trout, catfish, crappies and yellow perch. R173

### R70-14 SURFACE MINING & RESTORATION ENGLISH-STYLE

Singhal, R. K., Coal Mining Process. 7 (7), 40-43 (1970). In the Radar North project in Northumberland County, England, seams of coal 15" to 56" thick and at a maximum depth of 230 ft are mined. Giant draglines lifting 100 tons of material then replace the spoil material immediately following the mining operation. The National Coal Board expects operators to leave the land in better shape than before work started. R248

### R70-15 REVEGETATION OF STRIP MINE SPOIL BANKS THROUGH IRRIGATION WITH MUNICIPAL SEWAGE EFFLUENT AND SLUDGE

Sopper, W. E. (Penn State Univ., School Forest Resour.), Compost Sci. Nov.-Dec. 1970. pp 6-11. Penn State Univ., Inst. Land Water Resour., Reprint Ser. No. 20. A controlled study shows that trees, grasses, and legumes can be

R70-15 (continued)

successfully grown on strip-mine spoil irrigated with both municipal sewage effluent and sludge. Data are tabulated for sewage composition, plant growth and survival, and composition of effluent from sewage treated and untreated spoil. R500

R70-16 RECLAMATION OF TOXIC COAL MINE SPOIL BANKS

Sutton, P., Ohio Rept. Res. Develop. 55 (5), 99-101 (1970). Lime, phosphorus and potassium were used to treat acid refuse. By controlling pH level, vegetation prospered and in all cases when pH dropped to 4 and below growth disappeared. 70-110

R70-17 THEY GIVE THE LAND ANOTHER CHANCE

Reprinted from The Ohio Edisonian, Aug. 1970. 3 pp. The reclamation program of the Ohio Edison Company, begun in the late 1940's, is pictured. In many cases the final grading and planting restore the land to a more desirable condition than existed before the strip mining. R357

R70-18 TRUAX-TRAER MINES BY MASTER LAND-USE PLAN

Consol News 9 (5), 17-19 (1970). The projected plan for reclaiming land to be mined near Canton, Illinois is described. The area will include a golf course and other recreational areas. R225

R70-19 GROWTH AND MANAGEMENT OF BLACK WALNUT (JUGLANS NIGRA L.) ON STRIP-MINED LANDS IN SOUTHEASTERN KANSAS

Geyer, W. A. and Naughton, G. G. (Kansas Agricultural Experiment Station, Manhattan), Transactions of the Kansas Academy of Science 73 (4), 491-501 (1970). In 1946, permanent plots were established from plantations of black walnut trees started from seed on strip-mined lands in Crawford and Cherokee Counties, Kansas, between 1933 and 1936. Surveys of survival and growth of black walnut and other species seeded or planted at the same time were carried out in 1967 and 1968 and showed a 24 percent loss of black walnut trees and a slowing of their growth. Since other studies showed the need of black walnuts for wide spacing, thinning plots were established near some of the permanent plots. After two growing seasons, measurements indicated that the trees were responding to thinning. In managing the plantations as wildlife habitat, trees were felled with hinges of wood attached to the stumps. Some treetops were living after the second growing season, and, with sprouts from the stumps, provided "living" brush piles for animal cover. CE486

### R70-20 TREE PLANTING GUIDE FOR THE RECLAMATION OF STRIP MINE LANDS IN OHIO

Paton, R. R., Deane, J. A., Kohl, E., Krause, R. R., Richter, D. E., and Soine, G., Ohio Reclamation Association, Technical Bulletin No. 70-1, June 1970. 14 pp.+ Tree planting methods, aids in selection of species, information on where to obtain additional technical assistance, and a summary of reforestation carried out over the years are included in this guide. R843

### R70-21 RESTORING PRODUCTIVITY OF COAL MINE SPOILBANKS

Sutton, P., Ohio Report, July-Aug. 1970. pp 62-63. The article describes the work of the Eastern Ohio Resource Development Center in reclaiming spoil banks with limestone and mulch. Studies showing the production of acid from spoil are also reviewed. R813

### R70-22 STRIPMINE RECLAMATION

Vimmerstedt, J. P., Ohio Report, July-Aug. 1970. pp 60-61. Progress in surface-mine reclamation in Ohio in the 22 years since the passage of the first reclamation law in 1948 is reviewed. R814

### R70-23 AFTER THE MINING...USEFUL LAND

Whitt, D. M. (U.S. Department of Agriculture, Soil Conservation Service), Mining Congr. J. 56 (5), 26-29 (1970). This article describes the involvement of the Soil Conservation Service since the 1930's with surface mine reclamation. Extent of land needing reclamation in 13 states is noted as is the reclamation work of the mining industry. R871

## 1971

### R71-1 COAL MINING AND ITS EFFECT ON WATER QUALITY

Ahmad, M. U. (Ohio Univ.), Proc. Groundwater Pollut. Conf., St. Louis, Mo., 1971. (pp 13-52). The effects of surface and deep mining on water quality are discussed in depth with conditions of mines in Ohio serving as the main examples. 71-115

### R71-2 EFFECTS OF STRIP MINING ON SMALL-STREAM FISHES IN EAST CENTRAL KENTUCKY

Branson, B. A. and Butch, D. L., Proc. Biol. Soc. Wash. 84 (59), 507-18 (1971). Leatherwood Creek and Bear Branch Creek, Breathitt County, Kentucky were monitored to observe effects of strip mining on fish populations. Siltation, not acidity, was the main pollutant resulting from strip mining. Numbers of bottom feeders declined earliest. Investigation of the stream showed that this was at least partly due to reduction of benthic food organisms and the reduction in darters and minnows, either by prevention of

R71-2 (continued)

mating or destruction of fry and eggs. Monitoring of the streams is planned to be continued. R51

## R71-3 MINED-LAND REDEVELOPMENT: SOUTHEAST KANSAS PORTION OF THE OZARKS REGION

Camin, K. Q., Hardy, R. G., and Hambleton, W. W., Final Rept. for the Ozarks Regional Comm., Con. No. ORC TA 70-19 (NEG), Oct. 15, 1970-Oct. 15, 1971. 36 pp. Information on the location, ownership, and characteristics of mined land located in the area is reported and includes land disturbed by lead and zinc mining as well as by coal mining. Research and demonstration projects on land reclamation sponsored under this program are reviewed. R40

## R71-4 ARNOT BRISTLY LOCUST--A NEW PLANT FOR RECLAMATION AND BEAUTIFICATION

Chironis, N. P., Coal Age 76 (9), 84-87 (1971). Arnot bristly locust is an attractive and remarkably vigorous plant discovered by the Soil Conservation Service. Arnot can survive and grow in highly acid locations. It is very drought tolerant, can be planted any time, spreads very rapidly and will grow on steep banks as well as on the level. It blooms from late May thru June with sweet pea-like rose-purple flowers each about an inch across, borne in clusters. Arnot bristly locust reaches a height of 8 to 10 feet and has the ability to fix its own nitrogen thus reducing need for fertilizers. R437

## R71-5 CLEAN AIR & WATER

Coal Mining Process. 8 (11), 65-66 (1971). Kaiser Resources Ltd. has a program to minimize air and water pollution at their coal mining and processing operations at Sparwood, British Columbia. Sludge lagoons used for refuse slurry are checked regularly for leakage. Water samples are taken above and below the current stripping operations on Harmar Ridge and wildlife surveys are conducted in cooperation with the B.C. Department of Conservation and Recreation, Fish and Wildlife Division. Runoff and ground water are sampled regularly to determine the amount of solids, acids, and metals. Clarified water is pumped to the plant as makeup water. R137

## R71-6 COAL, CONSOL AND THE ENVIRONMENT - A SPECIAL REPORT

Reprinted from Consol News 10 (1) (June 1971). 36 pp.+ This booklet describes numerous pollution control operations of Consolidation Coal Co. including laboratory testing and control work on mine waters; Bergaman Creek, Blacksville and Mingo mine drainage treatment plants; the Pocahontas Fuel Division's Lynco refuse pile terraced and seeded; the Sallie Buffalo Park near Cadiz, Ohio; the Edgell Water Treatment Plant near Wyatt, W. Va.; the Hanna Reclamation Program and the Kathleen Mine Reclamation Project of Truax-

R71-6 (continued)

Traer Division near Duquoin, Illinois. The Truax-Traer Division buries its refuse by replacing it in the original strip pit. R338

R71-7 FARMING FOR PROFIT ON RECLAIMED LAND

Cornforth, C. L., Coal Mining Process. 8 (8), 32-36 (1971). Meadowlark Farms, Inc., the reclamation and land management branch of Ayrshire Coal Co., runs farms covering 85,000 acres of both unmined and reclaimed coal lands in Illinois and Indiana. In 1970, the farms produced 360,000 lbs of pork, 450,000 lbs of beef and 600,000 bu of grain. R469

R71-8 STRIP-MINING, EROSION AND SEDIMENTATION

Curtis, W. R., Trans. ASAE 14 (3), 434-436 (1971). Spoil banks are a heterogeneous mixture of sandstone, limestone, shale, and soil. There is no developed soil zone and very sparse vegetation. Weathering and erosion begin on the spoil bank as soon as the mining operation exposes the unconsolidated and unprotected material. The rate of weathering is faster in this freshly exposed material than in unmined areas. Generally, larger storms produce more sediment, but the maximum concentrations of sediment also depend on the area disturbed and whether mining is active. (From author's summary) R141

R71-9 TERRACES REDUCE RUNOFF AND EROSION ON SURFACE-MINE BENCHES

Curtis, W. R., J. Soil Water Conserv. 26 (5), 198-9 (1971). A two-year study in Breathitt, Kentucky indicated that terraces can effectively control runoff and erosion on surface-mine benches. In an area where the spoil was predominantly shale, peak flows on a terraced plot averaged 65 percent less than on a control plot, sediment yield averaged 52 percent less and total runoff averaged 42 percent less. Comparable figures on a set of plots having substantial amounts of sandstone were 65,70 and 6 percent respectively. Average storm runoff duration was 1 percent higher on the terraced plot of each pair. (Author's abstract). R139

R71-10 VEGETATING STRIP-MINE SPOILS FOR RUNOFF AND EROSION CONTROL

Curtis, W. R. (Northeastern Forest Expt. Sta., USDA), Proc. Revegetation Econ. Use Surface Mined Land Mine Refuse Symp., Pipestem State Park, W. Va., Dec. 2-4, 1971. pp 40-41. The functions and methods of vegetating strip-mine spoils are discussed generally. R409

R71-11 RESTORATION AND RECLAMATION OF OPENCAST SITES

Davison, D. J. (Natl. Coal Bd., Opencast Executive), Colliery Guardian, Ann. Review, 94, 99-102 (Sept. 1971). This article reviews the development of

R71-11 (continued)

opencast mining in the United Kingdom and the reclamation of mined land to agricultural and recreational uses. R438

R71-12 THE EFFECT OF IRRIGATION WITH MUNICIPAL SEWAGE EFFLUENT AND SLUDGE ON SELECTED TREES, GRASSES, AND LEGUMES PLANTED IN BITUMINOUS STRIP-MINE SPOIL

Dickerson, J. A., M.S. Thesis, Penn. State Univ., Dept. Forestry, Wildlife, 1971. 88 pp. In general, results indicate that municipal sludge and sewage effluent can ameliorate harsh conditions found on bituminous spoil banks. (From author's conclusions) R189

R71-13 EQUIPMENT GUIDELINES FOR SURFACE MINE RECLAMATION

Coal Age 76 (7), 94-95 (1971). Large track-type tractors are considered as good performers for surface-mine reclamation. Advantages and disadvantages of wheel dozers and wheel tractor scrapers are discussed. The difficulties of using large shovels and draglines in reclamation work are pointed out. R616

R71-14 PRELIMINARY REPORT OF WATER QUALITY MEASUREMENTS AND REVEGETATION TRIALS ON MINED LAND AT LUSCAR, ALBERTA

Etter, H. M., Canadian Forestry Service, Northern Forest Research Centre, Edmonton, Alberta, Internal Rept. NOR-3, Aug. 1971. 19 pp. This report concerns a project around the Camp, Cabin, and Luscar Creeks in the Upper Foothills of western Alberta, Canada. The project involved water sampling and testing in addition to a revegetation activity of hydroseeding on weathered sandstone and shale overburden. Five seed mixtures were used and a tabulation gives the grasses and legumes and their maximum expected number of germinants. Several sketches and diagrams show the location and position of the test areas. A detailed tabulation of the water sample analyses is also given. Evaluation of the seeding project was not possible since the project had just begun and very little growing time had elapsed. Sediment, including coal particles, was also monitored. 71-107

R71-15 SURFACE MINED AREAS: CONTROL AND RECLAMATION OF ENVIRONMENTAL DAMAGE

Frawley, M. L., U.S. Dept. Int., Office Library Serv., Bibliography Ser. No. 27, (Sept. 1971). 63 pp. This bibliography contains 387 items under several categories; i.e., General, Environmental Effects, Protective Measures, Reclamation and Addenda. A name and subject index appear at the end of this bibliography. R50

R71-16 MINE SPOIL POTENTIALS FOR WATER QUALITY AND CONTROLLED EROSION

Grube, W. E., Jr., Jencks, E. M., Singh, R. N., Smith, R. M., and Wilson, H. A. (Div. Plant Sci., College Agr. and Forestry, W. Va. Univ.), U.S. EPA Water Pollut. Contr. Ser., 14010 EJE 12/71 (1971). 206 pp. The general goal of this research has been to provide sufficient information about coal overburdens and spoils to enable operators to place, treat and manage variable spoils in the most favorable manner to give water and soils of good quality during surface mining and thereafter. (From author's introduction) R81

R71-17 A GUIDE FOR REVEGETATING BITUMINOUS STRIP-MINE SPOILS IN PENNSYLVANIA

Res. Comm. Coal Mine Spoil Revegetation in Pa., Revised 1971. 46 pp. Recommendations for revegetating areas for agriculture, woodland, and wildlife habitat are given in this guide which is a cooperative effort of the U.S. Forest Service, U.S. Soil Conservation Service, Pa. Dept. Environmental Resources, Pa. Game Comm., Pa. Conservation Assoc., and Penn. State Univ., School of Forestry. There is also a bibliography of pertinent literature. R16

R71-18 IMPACT OF SURFACE-MINED BITUMINOUS COAL AND LIGNITE ON U.S. ENERGY SECTOR

National Coal Association, (undated). 24 pp. This booklet gives statistics showing the production of coal and the energy produced from coal in comparison to electric energy generated from other sources of power. The most recent figures given are for 1971 and these are compared to earlier years, in the case of coal production, back to 1940, and in the case of electric power generation, back to 1966. Estimated strippable resources and reserves are given as of January 1, 1968. R241

R71-19 PEABODY COAL FUELS ANOTHER POWER PLANT

Jones, D. C., Coal Mining Process. 8 (9), 48-51 (1971). The mining reclamation operation at Peabody's Universal Mine near Terre Haute, Ind. is described. Production is about 6,000 tpd and dedicated to a plant of Public Service of Indiana. R134

R71-20 ON RECLAIMED SPOIL BANKS - TIMBER! - AND IN NINE YEARS AT THAT!

Jones, W. G., Coal Age 76 (11), 58-61 (1971). The reforestation project of the Hoffman Coal Co. at Karthaus, Pa. was first planted in 1962 and growth after nine years is over 11 inches in diameter and 40 feet high or better. Lumber value is now more than $40/acre. Rainfall during this nine-year period was about one fourth the normal amount. Cuttings were kept in damp sawdust over the winter--then bundles of 20 kept this way until spring.

R71-20 (continued)

Hybrid poplar is the most successful but some evergreens were also planted. Pictures of the planted areas show the good success achieved. R32

### R71-21 SUCCESSFUL NUT TREE PLANTINGS ON BITUMINOUS SPOIL BANKS IN PENNSYLVANIA

Jones, W. G., 62nd Ann. Rept. Northern Nut Growers Assoc. (1971). pp 22-5. This reprint describes the success achieved by the author growing nut trees in the rocky soils of reclaimed spoil banks. Some species of Chinese Chestnut trees grew much better than on good farm soil. Their disadvantage as a tree is its shrubby growth. Deer are a problem because they keep young nut trees clipped to the ground level. The author also transplanted a number of Black Walnut trees and a 90 percent survival resulted. Several other nut species have been tried with good success. R70

### R71-22 LAND RECLAMATION CAN EVEN BE PROFITABLE

Mining Congr. J. 57 (12), 57-60 (1971). The Ayrshire Coal Company has practiced scientific farming for 25 years. The products and cattle produced on reclaimed farm land are pictured. Reforestation is only used when the land is considered not suitable for farming. R107

### R71-23 RECLAMATION OF STRIP MINE SPOIL BANKS IN WYOMING

Lang, R., Univ. Wyoming, Agr. Expt. Sta., Res. J. 51 (Sept. 1971). 32 pp. This report has been compiled from theses written by three management graduate students plus reports by Professor Morton May. This information contains a description of the study area and characterization of different-aged spoil banks. Tree planting research, grass seeding, and grass transplanting were investigated for establishment of vegetation on overburden piles. Early spring was best time to plant, early fall was least successful. Sodding produced far better results than sprigging. Age of overburden did not affect planting success but planting behind snowfence gave slightly better survival rate. The most limiting factor was amount of moisture received during and after planting. Russian olive and caragana were the best adapted tree species. Sodded grasses were most effectively established on flat-top spoil piles whereas trees and seeded grasses were more effectively established on northeast and east facing slopes. R69

### R71-24 AN UNUSUAL COAL MINE/POWER PLANT COMPLEX

Levene, H. D., Coal Mining Process. 8 (10), 57-61 (1971). In northeastern Wyoming, Wyodak Coal Mine produces coal from a 90-foot seam for the Neil Simpson Power Plant. The mining operation, reclamation, and power plant operation are described. R135

R71-25 A LONG RANGE RECLAMATION PROGRAM

Coal Mining Process. 8 (11), 62-4 (1971). Planning for reclamation of strip mines in the Elkview Coal Mining Complex in British Columbia has started with experimental work to find the types of trees and shrubs that can best be used for revegetation at the high altitude of the mines. Old strip-mine sites are being used in the experimental work and are also being reclaimed. R136

R71-26 ENVIRONMENTAL MANAGEMENT AND REGIONAL ECONOMIC DEVELOPMENT

Miernyk, W. H. (W. Va. Univ., Reg. Res. Inst.), Southern Econ. Assoc. and Southern Reg. Sci. Assoc. Meet., Miami Beach, Fla., Nov. 6, 1971. 17 pp.+ This paper discusses the overall economic effects in West Virginia if all strip mining were stopped in favor of deep mining. The author discusses EPA's policy and the problems of enforcement of their standards. Several pages of statistics are included to illustrate the economic effects. R82

R71-27 MINED-LAND REDEVELOPMENT WORKSHOP

Kansas Geol. Surv., Special Dist. Publ. 58, 1971. 48 pp. (Appendix E to Camin, K. Q., et al "Mined-land redevelopment: southeast Kansas portion of the Ozarks region," Final Rept. for Ozarks Regional Comm. Con. No. ORC TA 70-19 (NEG) 1971. 36 pp). The workshop proceedings include the following papers: Hambleton, W. W., "The geological context of mined-land redevelopment," pp 5-7. Camin, K. Q., "An action plan for redeveloping southeast Kansas lands," pp 9-14. Murphy, L., "Effects of fly-ash as a soil amendment on strip-mined soils," pp 15-20. Grandt, A. F., "Agriculture crops on mined lands," pp 21-4. Hyde, R. M., "Mined land reclamation," pp 25-8. Capp, J. P. and Adams, L. M., "Reclamation of acid spoil with power plant fly ash," pp 29-39. Kovacic, W., "Fly ash research test plots," pp 41-2. R41

R71-28 THE BUREAU OF MINES RESTORATION WORK IN APPALACHIA

Pense, R. A., Appalachia 4 (5), 18-20 (February 1971). This article describes the reclamation work in the Appalachian Area sponsored by the Federal Government which pays 75 percent of the costs, mainly under the Appalachian Regional Development Act. After individual projects are approved by the Bureau of Mines, private contractors who are successful bidders do the work. Some of the projects described are mine fire control, subsidence, land reclamation, and oil and gas well sealing. By 1970 there were 25 commission-approved mine restoration projects in progress at a total cost of approximately $24 million. R48

R71-29 HIGHWALLS - AN ENVIRONMENTAL NIGHTMARE

Plass, W. T., Proc. Revegetation & Economic Use of Surface-Mined Land and Mine Refuse Symp., Dec. 2-4, 1971. pp 9-13. This article discusses the unsightly appearance of the highwall and describes this as a major objection

R71-29 (continued)

to surface mining. The author then outlines several ways to screen from view most of the exposed highwall. This can be done by creating two benches which actually add to the total land disturbance. Other alternatives are shown by diagrams which use grading to minimize the total exposed area. These graded areas can then be planted with fast-growing trees which will screen a considerable part of the exposed highwall. R242

## R71-30 PROC. REVEGETATION ECONOMIC USE SURFACE-MINED LAND MINE REFUSE SYMP., PIPESTEM STATE PARK, W. VA.

by W. Va. Univ., School of Mines, College Agr. Forestry, Appalachian Cent., Dec. 2-4, 1971. 59 pp. The Proceedings include the following papers on surface-mined land reclamation: Glover, F. W., Jr., "Surface mine reclamation-preplanning"; Smith, R. M., "Properties of coal overburden that influence revegetation and economic use of mine soils"; Anderson, J. C., "Preparation of surface-mined land for revegetation"; Plass, W. T., "Highwalls--an environmental nightmare"; Vogel, W. G., "Needs in revegetation research on surface-mined lands"; Balasko, J. A., "Plant and spoil characteristics affecting surface mine revegetation"; Vande Linde, O. V., Jr., "Vegetation and techniques currently used in revegetation of surface-mined land"; Bennett, O. L., "Grasses and legumes for revegetation of strip-mined areas"; Brown, J. H., "Use of trees for revegetation of surface-mined areas"; Hardin, N. C., "Use of specialty crops for revegetation on surface mine areas"; Rawson, J. W., "Surface mining and wildlife"; Curtis, W. R., "Vegetating strip-mine spoils for runoff and erosion control"; Sperow, C. B., Jr., "Continuing management of vegetation on surface-mined land"; Sutton, P., "Continuing management of vegetation on surface-mined land"; Eigenbrod, W. F., "Use of stabilizers and binders for conditioning surface-mined land and coal mine refuse for revegetation"; Capp, J. P. and Adams, L. M., "Reclamation of coal mine wastes and strip spoil with fly ash"; Ozmina, D. J., "Industry experience in revegetating with grasses, legumes and related plants"; Smith, W. D., "Industry experience in revegetating with trees"; Frederick, G. B., "Industry experience in revegetating with specialty crops." R430

## R71-31 RECLAMATION AND BIG DOZERS AT HANNA COAL

Coal Age 76 (5), 80-3, 88 (1971). Hanna Coal Company has used Allis-Chalmers HD41 dozers to handle its reclamation work. The machinery and the land grading practice are described. Hanna began reclamation work in the early 1940's and details of their program, which has used crown vetch very successfully, are outlined. R106

## R71-32 RECLAMATION...A PEABODY COAL ENVIRONMENTAL SPECIALTY

Coal Age 76 (10), 124-129 (1971). Peabody Coal Company's multiple-use environmental policy is operated by a special staff of 11 men. Included in their reclamation plans are development of lakes, especially for recreation; timber

R71-32 (continued)

production, grazing lands; wildlife support; and water quality control. R470

R71-33 RECLAMATION: RESTORING BEAUTY AND BALANCE

U.S. Steel News 36 (6), 8-10 (Nov./Dec. 1971). This article explains the reclaiming efforts of U.S. Steel at its coal properties. The work was started more than twenty years ago and many details outline what has been learned and accomplished in that time. The various seeding methods and their effectiveness are discussed. R27

R71-34 REMOTE SENSING FOR MINED AREA RECLAMATION: APPLICATIONS INVENTORY

Earth Satellite Corp., prepared for U.S. Bureau of Mines, June 1, 1971. 15 pp.+ This is a survey of the use of remote sensing, mainly by aerial photography, for coal companies, government organizations and others in monitoring conditions in mined-land areas. R49

R71-35 SOIL DEVELOPMENT ON MINE SPOIL

Smith, R. M., Tryon, E. H., and Tyner, E. H., W. Va. Univ., Agr. Expt. Sta., Bull. 604T (1971). 47 pp. Iron ore spoils, 70 to 130 years old, were studied and compared to recent coal spoils and natural contiguous soils to evaluate the long-range potential of coal spoils for good growth. R439

R71-36 ACID MINE POLLUTION EFFECTS ON LAKE BIOLOGY

Smith, R. W. and Frey, D. G., Water Resour. Res. Center, Indiana Univ., Rept. to U.S. EPA, Water Pollut. Contr. Res. Ser. 18050 EEC 12/71 (1971). 131 pp. Six coal strip-mine lakes in Pike County, southern Indiana, ranging in pH from 2.5 to 8.2 were studied from July 1969 to December 1970. Results of the sampling program for physical and chemical parameters and for biological parameters are reported. Generally, differences between the lakes indicated successional trends with increasing pH. R28

R71-37 EFFECTS OF IRRIGATION OF MUNICIPAL SEWAGE EFFLUENT ON SPOIL BANKS

Sopper, W. E., Penn. State Univ., Inst. Res. Land Water Resour., Rept. to U.S. Dept. Int., Office Water Resour. Res., Dec. 1971. 9 pp. NTIS, PB-207 784. Spoil materials together with sewage effluent and sludge in various blends were tested with tree, grass, and legume plantings. Results showed that considerable amounts of dissolved minerals were removed by the spoil material, and the quality of the percolating water was greatly improved. R158

## R71-38 STRIP-MINED AREA RESTORATION

Fact Sheet, Northeastern Forest Expt. Sta., Upper Darby, Pa., 1971. This one-page report describes Project No. 1605 in Berea, Kentucky to develop practical methods of reducing damage to water, wildlife, recreation, timber, and range resources during surface-mining operations and to develop practical methods of restoring these resources once surface-mining operations have been completed. Forestry scientists at Berea are conducting research in four major problem areas, engineering, spoil bank chemistry, hydrology, and revegetation. R18

## R71-39 STRIP MINING STUDY: A PRELIMINARY REPORT FOR MINING FOUR COAL SEAMS ON BUSHY MOUNTAIN IN CAMPBELL COUNTY, TENNESSEE

Tennessee Valley Authority, Office Eng. Design Construction, Sept. 1971. 8 pp.+ In the mining plan described, overburden initially is placed either in a spoil area or on outslope in a way to insure slope stability. Overburden from succeeding cuts is stored on the previous bench or used to fill in previously excavated areas. Plans, including costs, are given for three different situations of spoil placement on the outslope: 40-foot fill height; 20-foot fill height; and no fill on the outslope. R573

## R71-40 SURFACE MINING

Coal Age 76 (7), 193-209 (1971). This general article on surface mining emphasizes the general material moving and handling problems, and includes discussion of waste disposal and handling overburden. Details of grading and all types of seeding and revegetation are discussed. Reference is made to the importance of speeding reclamation work. R464

## R71-41 SURFACE MINING CONSERVATION AND RECLAMATION ACT (PENNSYLVANIA)

Act of May 31, 1945, P.L. 1198, Act No. 418 and Amendments, including Act No. 147, Nov. 30, 1971. (52 P.S. 1396.1 et seq.) 14 pp. Extraction of non-coal minerals is also covered by the act except as specifically exempted. There are requirements for mining permits, reclamation planning and bonds. Provision is made for a Surface Mining Conservation and Reclamation Fund. R47

## R71-42 SURFACE MINING, SOLID WASTE DISPOSAL COMBINED AT PENNSYLVANIA OPERATION

Coal Age 76 (11), 84-6 (1971). The combined strip mining, solid-waste disposal, and land-reclamation operation of Aloe Coal Co., west of Pittsburgh, is described. R103

R71-43 RECLAMATION OF TOXIC SPOIL BANKS

Sutton, P. (Ohio Agr. Res. Develop. Cent.), Acid Mine Drainage Workshop, Athens, Ohio, by Ohio Univ., 1971. 4 pp. This paper describes the neutralization requirements of spoil banks in order to have these support vegetation. pH below 4 prevents all growth but there are banks which are acid but not toxic, where certain plants will grow. Soil cover over spoil material will support vegetation and roots will eventually grow into spoil material. R550

R71-44 SYMPOSIUM PROCEEDINGS - REHABILITATION OF DRASTICALLY DISTURBED SURFACE MINED LANDS

Macon, Ga. by Georgia Surface Mined Land Use Board, Nov. 4-5, 1971. 126 pp. The problems of reclamation of surface-mined land are treated generally although there are a number of mentions of kaolin mining since that is one of Georgia's largest surface mining industries. Among subjects discussed in various papers are land-use planning, legislative requirements for reclamation, vegetation, water and erosion control, dust control, developing lands for fishing, or sanitary land fills. R143

R71-45 THE REHABILITATION OF THE MINING ENVIRONMENT IN BRITISH COLUMBIA

Thirgood, J. V., Can. Mining Met. Bull. 64 (712), 90-5 (1971). This article describes the surface-mining circumstances in British Columbia and the legislation that regulates reclamation. Examples are given of the implementation of the legislation. The Canadian Forestry Service Information Report A-X-34 by Peterson and Etter is cited as giving significant information on how to plan for effective reclamation and its recommendations are reviewed. R220

R71-46 EFFECTS OF SPOIL TEXTURE ON GROWTH OF K-31 TALL FESCUE

Van Lear, D. H., U.S. Forest Serv. Res. Note NE-141 (1971). 7 pp. The growth of K-31 tall fescue was significantly affected by the particle size distribution, or texture, of four spoils from Eastern Kentucky. Growth on non-toxic spoils was greatest where the texture consisted of about equal quantities of soil-size material and a coarser fraction (2 mm to 6.4 mm) probably because moisture and aeration were more favorable. On two spoils adverse chemical properties modified the effect of physical properties associated with texture. Toxic levels of Mn found in the smaller size fractions probably reduced yields on one spoil. On another the effect of texture was masked by toxic levels of Al in each of the three particle size fractions. (Author's abstract). R133

R71-47 NEEDS IN REVEGETATION RESEARCH ON SURFACE-MINED LANDS

Vogel, W. G. (Northeastern Forest Expt. Sta. USDA), Proc. Revegetation Econ. Use Surface-Mined Land Mine Refuse Symp., Pipestem State Park, W. Va.,

R71-47 (continued)

Dec. 2-4, 1971. pp 17-18. Research needs cited include erosion control studies, fertilizer requirements, feasibility of alternate land use, and treatment of problem spoils. R410

R71-48 RECLAMATION OF ACIDIC COAL-MINE SPOIL WITH FLY ASH

Adams, L. M., Capp, J. P., and Eisentrout, E., U.S. Bureau of Mines, RI 7504 (Apr. 1971). 29 pp. Plots at two sites in northern West Virginia were treated with varying tonnages of fly ash from three area powerplants and were planted with a variety of grasses, legumes, trees, and shrubs. Eight grasses and seven legumes were investigated. Greatest promise for growth under harsh soil conditions was shown by Kentucky 31 fescue, rye and red top grasses, and birdsfoot trefoil, a legume. Survival of trees and shrubs was negligible. Addition of fly ash to the spoil increased the pH to a range tolerable to some types of plant growth, improved the texture of the soil, and increased the available water of the resulting mixture. (From authors' abstract). BurM

R71-49 EFFECTS OF STRIP MINING AND TECHNOLOGICAL CHANGE ON COMMUNITIES AND NATURAL RESOURCES IN INDIANA'S COAL MINING REGION

Callahan, J. C. and Callahan, J. G., Purdue University Agricultural Experiment Station, Research Bulletin No. 871 (Jan. 1971). 43 pp. This detailed study of surface mining in Indiana includes information on reclaiming the land by forestation and the use of the reclaimed land for recreation. R950

R71-50 THE INDIANA COAL INDUSTRY SURFACE MINING RECLAMATION PROGRAM

Medvick, C. (Mid-West Coal Producers Institute, Inc.), Indiana Academy of Science Proceedings 80, 346-350 (1971). The scope and longevity of surface mining reclamation in Indiana are described. Organized, continuous planting was started in 1926. A table gives a chronological listing of the 16 conifer and 28 broadleaf species planted over the years. Revegetation to forage crops was increased in the more recent years. The author notes the adverse effects on tree survival and growth from compaction of earth resulting from the grading required by the 1967 reclamation law. R876

R71-51 RECLAMATION: U.S. STEEL IS INVOLVED

Coal Age 76 (4), 66-71 (1971). The reclamation program carried on by U.S. Steel at its Gary District in McDowell County, West Virginia, since 1948 is described. Hydraulic seeding was found to be an economical and efficient method of sowing grass, shrub, and tree seeds, either separately or in a mixture, and with the addition of fertilizer and/or mulch. Plant selection studies are part of the research program. A number of species used are discussed and their advantages and disadvantages are pointed out. Jour

R71-52 THE DEVELOPMENT AND USE OF COAL SURFACE-MINED LANDS IN ILLINOIS

Weber, L. S. (Mid-West Coal Producers Institute), in Land-Use Problems in Illinois, Papers from a Symposium at the 137th Meeting of the American Association for the Advancement of Science, Chicago, Illinois, Dec. 26-31, 1970, Illinois State Geological Survey, Environmental Geology Notes Number 46 (May 1971). pp 41-46. The history of surface mining and reclamation in Illinois is reviewed. Revegetation changed from early emphasis on reforestation to planting with forage crops and developed from trial and error to plantings based on scientific studies. Recreational areas developed around the lakes created by surface mining are described, as are other uses of mined land. IllGeol

## 1972

R72-1 COAL MINE SPOIL AND REFUSE BANK RECLAMATION WITH POWERPLANT FLY ASH

Adams, L. M., Capp, J. P., and Gillmore, D. W. (U.S. Bur. Mines), Proc. Third Miner. Waste Utilization Symp., Chicago, Ill., by U.S. Bur. Mines and IIT Res. Inst., 1972. pp 106-111. The field treatments of surface-mine spoil in a long-range combination field and greenhouse study are emphasized. Benefits of reclaiming both surface-mine spoil and coal mine refuse include partial neutralization of acid spoil and refuse materials; increase in moisture-holding capacity and pore space of moisture-holding materials; yields of forage that compared favorably with yields from undisturbed pastures and fields; use of large amounts of fly ash. Information tabulated includes composition of fly ash used, chemical analysis of surface-mine spoil at treated sites, and costs of reclamation. 622 M6

R72-2 ADMINISTRATION OF REGULATIONS FOR SURFACE EXPLORATION, MINING AND RECLAMATION OF PUBLIC AND INDIANA COAL LANDS

Comptroller General of the United States, Rept. to Conservation and Natural Resour. Subcomm., Comm. Gov. Operations, U.S. House Representatives, B-148623, 1972. 36 pp. GAO's review was limited to the administration of the regulations for coal resources. GAO also considered whether the Department of Interior was applying the regulations consistent with the mandates of the National Environmental Policy Act of 1969 and the regulations provided assurance that valuable resources were not being depleted without protection of environmental values. The review was made in Arizona, Colorado, Montana, New Mexico, North Dakota, and Wyoming and in Department of Interior headquarters offices in Washington. (From digest of report) R463

R72-3 SPOIL, GOB AND FLY ASH PRODUCE PLANT SUPPORTING SOILS

Babcock, A., Green Lands 2 (1), 10-13 (1972). Fly ash is a good neutralizing agent and soil additive as shown by a table comparing mineral value of ash with regular fertilizers. Fly ash increases the moisture-holding capacity of spoil material. Treated plots showed impressive growths. A calculation of mineral values in fly ash showed the equivalent cost benefits to be $529/acre. R118

### R72-4 EVALUATION OF ABANDONED STRIP MINES AS SANITARY LAND FILLS

Bodner, R. M. and Hemsley, W. T. (Nassaux-Hemsley, Inc.), Proceed. Third Miner. Waste Utilization Symp., Chicago, Ill., by U.S. Bur. Mines and IIT Res. Inst., 1972. pp 129-138. This article explains and illustrates the merits of combining reclamation with disposal of municipal wastes. First it is necessary to study the soils and characteristics of the strip mine. Precautions must be taken to ensure that leachate does not pollute the ground or surface waters. A number of actual landfill operations are described. Soil, geologic, and hydrologic considerations determine the suitability of a strip mine as a landfill. Constraints against this practice are predominantly social and legislative. 662 M6

### R72-5 ECOLOGY AND PRODUCTIVITY OF STRIP MINE AREAS IN MERCER COUNTY, PENNSYLVANIA

Brenner, F. J. (Grove City College, Pa.), Study funded by U.S. Dept. Int., (undated). 70 pp. A study of 81 abandoned strip mines in Mercer County was carried out in 1971 and 1972. Water analyses and studies of plankton and fish population of strip-mine ponds showed that most ponds were capable of supporting aquatic life. In vegetative analyses of the land, natural vegetation was differentiated from vegetation planted during reclamation. The success of 16 species of grasses and 30 species of trees planted by the Soil Conservation Service was evaluated and the results are tabulated. R588

### R72-6 RECLAMATION OF SURFACE MINED AREAS IN MOUNTAINOUS TERRAIN

Caffrey, J. E. (U.S. Steel Corp., Gary, W. Va. Coal Dist.), AIME Ann. Meet., San Francisco, Calif., Feb. 20-24, 1972. Preprint No. 72-F-51. 17 pp. United States Steel Corp. has reclaimed to forest land rugged and mountainous areas it strip mined in southern West Virginia. Forty-four slides shown with the presentation are reproduced. R574

### R72-7 CAPITOL FUELS' STRIP MINE FRUIT ORCHARD

Coal Mining Process. 9 (7), 50-51, 60-61 (1972). Capitol Fuels and its sister company, F & F Mining, have converted an active strip mine near Charleston, W. Va. into a fruit orchard in one year. They have also planted various grasses and legumes on former mine sites. The companies use silt dams to trap solids before water enters the streams and check water samples regularly. R423

### R72-8 A PRELIMINARY DESCRIPTION OF THE PHYSICO-CHEMICAL CHARACTERISTICS AND BIOTA OF THREE STRIP MINE LAKES, SPENCER COUNTY, INDIANA

Coe, M. W. and Schmelz, D. V. (St. Meinrad College), Proc. Ind. Acad. Sci. 82, 184-188 (1972). Three Spencer County strip-mine lakes in the same immediate area, each about 30 years old, were studied. Differences between the

R72-8 (continued)

characteristics of the lakes are a function of area/volume ratios, slopes of basins, and watersheds. These lakes are in the alkaline stage of recovery. The study results prove that each lake is modified, chemically, physically, and biotically, at its own rate. 72-103

### R72-9 ALASKAN COALS MAY PROVE A BIG PLUS IN FUTURE EXPORTS PICTURE

Conwell, C. N., Mining Eng. 24 (10), 82-4 (1972). The coal fields of Alaska are described. Much of the coal is in thick seams which have a favorable ratio of seam thickness to depth of cover for strip mining. Sulfur content of the coal is very low. Coal deposits are almost all on Federal, state or native allotment lands. State and Federal regulations and administration of coal lands are discussed. R102

### R72-10 COST ANALYSES OF MODEL MINES FOR STRIP MINING OF COAL IN THE UNITED STATES

U.S. Bur. Mines, IC 8535 (1972). 116 pp. This study estimates costs of producing bituminous coal and lignite by strip-mining methods in 12 hypothetical mines. Costs are developed by geographic area, rank of coal and output capacity. Seam thickness, depth and type of overburden are considered typical for the area in which the hypothetical mine would be located. Cost analyses are based on use of new equipment, union wage scales, miscellaneous costs, royalties, miners' fund contributions, license and permit fees. The hypothetical mines have annual outputs of 1 to 5 million tons. Each mine has an assumed life of 20 years. Production costs for the 3-5 million ton mines average 30 percent below that of the 1 million ton/year mine. R72

### R72-11 STRIP-MINING INCREASES FLOOD POTENTIAL OF MOUNTAIN WATERSHEDS

Curtis, W. R. (Northeastern Forest Expt. Sta., Berea, Ky.), Natl. Symp. Watersheds in Transition, Fort Collins, Colo., by Am. Water Resource Assoc. and Colo. St. Univ., June 19-20, 1972. Proc. Ser. No. 14, pp 357-360. A study in eastern Kentucky indicated that surface mining for coal alters natural processes and affects the water resources in small Appalachian watersheds. Peak flow rates increased by a factor of 3 to 5 after surface mining. Lag time was reduced, thus affecting an increase in the rate at which flood peaks move downstream. It appears that peak flow is directly and positively correlated with the percent of area disturbed during surface mining. (Author's abstract) R6

### R72-12 MICRO-TOPOGRAPHIC PROFILE GAGE

Curtis, W. R. and Cole, W. D. (Northeastern Forest Expt. Sta., USDA), Agricultural Eng. 53 (1), 17 (1972). This article describes a simple gage which can be used to measure soil loss from surface-mined lands. A picture shows the

R72-12 (continued)

gage and a detailed description is given explaining its construction and use. R140

## R72-13 SPROUTING OF THINNED HYBRID POPLARS ON BITUMINOUS STRIP-MINE SPOILS IN PENNSYLVANIA

Davidson, W. H. and Davis, G. (Northeastern Forest Expt. Sta.), U.S. Forest Serv. Res. Note NE-147 (1972). 6 pp. Various thinning techniques were applied to 5-year old hybrid poplar stands on bituminous strip-mine spoils. Basal and stump sprays of 2, 4, 5-T in diesel oil were effective for killing the trees. There was no evidence that chemical treatments affected adjacent trees. Where trees were cut and stumps were not chemically treated, all clones sprouted prolifically. Dominance in sprout clumps was asserted soon after thinning. Sprouting vigor was affected more by site quality than clonal parentage. Results indicate that hybrid poplar can be successfully regenerated under coppice management or can be easily removed for stand conversion. (Authors' abstract) R356

## R72-14 SURFACE MINING PRACTICE IN CANADA

Dubnie, A. (Dept. Energy, Mines and Resources, Mining Res. Cent., Ottawa), Mines Branch, Inform. Circ. 292, 1972. 109 pp. This publication provides a general survey of equipment, methods and costs of surface mining in Canada. The final ten pages of this report deal with surface mining of coal. A tabulation is included giving location, company names, production, coal rank, thickness, seam attitude and overburden depth. Mining practices in various areas are described including details on waste disposal and reclamation. Several diagrams illustrate the stripping procedures and show how all material is handled. Reference is made to the revival of coal stripping in Canada due chiefly to new demands of the Japanese steel industry. R13

## R72-15 ENVIRONMENTAL PROTECTION--A CONSOL OBJECTIVE SINCE 1948

Coal Age 77 (10), 122-138 (1972). The overall mine drainage, reclamation and waste disposal program of Consolidation Coal Company is described. Fifteen water treatment plants are in operation and three more in development stages. Major projects for the company included: Itmann preparation plant, Hanna Coal Company Division reclamation program, the Pocahontas Fuel Company reclamation project, and Dents Run surface and water cleanup. Numerous pictures show conclusively the significant results obtained by the company's broad efforts in environmental control. Two maps show the extent of the areas improved by these reclamation efforts. Large sums of money have been spent at each location and these figures are included. R33

## R72-16 THE EXPERTS EVALUATE MOUNTAIN STATE RECLAMATION

Green Lands 2 (1), 18-21 (1972). Pictures showing the results of reclamation efforts in various parts of West Virginia were taken for the 1972 Interagency Evaluation of Surface Mine Reclamation in West Virginia. R119

## R72-17 FORESTRY RESEARCH HELPS MINE SPOILS TURN GREEN

Northeastern Forest Expt. Sta., U.S. Dept. Agr., Photo Story No. 12 (undated). 4 pp. The advantages of using weeping lovegrass to revegetate strip-mined land are discussed. Weeping lovegrass will grow on spoil as acid as pH 4; seems to compete less with young tree seedlings than do other plants used as cover on strip-mined land; and also seems to die out as the growing trees provide more protection to the reclaimed site. R572

## R72-18 A BIBLIOGRAPHY OF LITERATURE PERTINENT TO MINING RECLAMATION IN ARID AND SEMI-ARID ENVIRONMENTS

Gifford, G. F., Dwyer, D. D., and Norton, B. E., Utah State Univ., Aug. 1972. 23 pp. This compilation of 312 references covers reclamation from all types of mining. The references are categorized and the section covering coal spoil banks only has 34 references, but there are many coal-related references in other categories. R68

## R72-19 RECLAMATION OF SPOIL AND REFUSE BANKS WITH POWERPLANT FLY ASH

Gilmore, D. W. and Capp, J. P., AIME Ann. Meet., San Francisco, Calif., Feb. 20-24, 1972. Preprint No. 72-F-61. 17 pp. This paper describes the merits of fly ash as a soil conditioner for use in mine land reclamation work. The U.S. Bureau of Mines surface-mine reclamation program is summarized covering the years 1965 through 1971. In their program, they aimed for a neutral soil condition and blended fly ash accordingly with the gob-pile material and spoil. A number of projects are described and the physical and chemical benefits to the soil are listed. A cost study for this kind of reclamation produced a figure of $300/acre depending on a number of factors. R331

## R72-20 PREPLANNING ON SURFACE MINE LAND

Glover, F. W., Jr., Green Lands 2 (1), 23-25 (1972). This article points out that off-site damages should be minimized by making plans before mining begins. Preplanning should also include determination of future use of the area, maintenance of water quality, planning access roads, characterization of the overburden, and revegetation program. R120

### R72-21 LEGAL PROBLEMS OF COAL MINE RECLAMATION

Goldberg, E. F. and Power, G. (Maryland, Univ. of, School of Law), U.S. EPA, Water Pollut. Contr. Res. Ser., 14010 FZU 03/72 (1972). 236 pp. Coal mining produces a variety of environmental problems, - acid drainage, sedimentation, surface subsidence, and surface-scars. This study reviews the response of legal institutions to these problems in Maryland, Ohio, Pennsylvania and West Virginia. Technological and economic concerns are also taken into account. (From authors' abstract) R79

### R72-22 SURFACE MINING METHODS AND TECHNIQUES

Grim, E. C. and Hill, R. D., EPA, Natl. Environ. Res. Cent., Cincinnati, Ohio, Oct. 1972. 32 pp. This paper reviews the background of strip mining and describes the mechanics of the following methods: area mining, contour mining, slope-reduction method, slope-reduction method (parallel fill), pit-storage method, box-cut method - two-cut, head-of-hollow fill method, multiple-seam mining, auger mining, and highwall mining. Each section is complete with detailed sketches to show the actual material-handling sequences together with the reclamation procedures. R46

### R72-23 EFFECTS OF COAL MINING ON THE WATER RESOURCES OF THE TRADEWATER RIVER BASIN, KENTUCKY

Grubb, H. F. and Ryder, P. D. (U.S. Geol. Surv.), U.S. Geol. Surv. Water Supply Paper 1940 (1972). 83 pp. About 40 percent of the 12.1 million tons average annual production of coal in the Tradewater River Basin is from strip mining. The survey shows that more chemicals are carried in water from mined areas and that flow in streams draining mined areas is maintained during dry periods even after streams in non-mined subbasins have stopped flowing. R200

### R72-24 USE OF WASTE TREATMENT PLANT SOLIDS FOR MINED LAND RECLAMATION

Hinesly, T. D., Jones, R. L., and Sosewitz, B., Mining Congr. J. 58 (9), 66-73 (1972). The use of sewage sludge for mined land reclamation is advocated. It is claimed that hazard of contamination by pathogenic organisms can be eliminated by lagooning digested sludge for 30 days. Land disposal of sewage sludge is an advantage to a large metropolitan sanitary district even with the expense of transporting the material more than 100 miles. Sewage sludge can increase humus and nitrogen content of soils. R124

### R72-25 COAL MINE LAND RECLAMATION RESEARCH LOCATED AT WESTERN ENERGY COMPANY, COLSTRIP, MONTANA

Hodder, R. L., Sindelar, B. W., Buchholz, J., and Ryerson, D. E., Mont. Agr. Expt. Sta., Res. Rept. 20, 1972. 45 pp. The report gives the progress made in 1971 on research in five major areas: overburden analysis, mine water analysis, effectiveness and feasibility of topsoiling, development of optimum

R72-25 (continued)

fertilizer rates, and development of mechanical surface manipulation techniques. Twelve studies planned for 1972 are listed. Photographs of the work are included. R358

### R72-26 COAL MINE LAND RECLAMATION RESEARCH LOCATED AT DECKER, MONTANA

Hodder, R. L. and Sindelar, B. W., Mont. Agr. Expt. Sta., Res. Rept. 21, 1972. 29 pp. The research program at the Decker Coal Co. included overburden analyses; greenhouse testing for vegetation productivity potential; and field revegetation studies of over 40 individual seed mixtures containing over 70 plant species. R359

### R72-27 WHAT IS HAPPENING TO THE OHIO COAL INDUSTRY?

Hyslop, J. [V.P. (retired) Consolidation Coal Co.], Privately published after March 1972. (undated). 28 pp. The author is a former manager of strip mining for Hanna Coal Co., now speaking as an individual. He points out that the mining law now in existence will shut down every mine in Ohio if all phases of the law were to be enforced. Its requirements are completely impractical from an operating standpoint. An extensive section discussing reclamation which is information for the most part from Hanna's effective and successful program. Mr. Hyslop discusses all phases of reclamation and is of the opinion that the administration and enforcement of the Ohio laws has been very faulty and unsatisfactory. R14

### R72-28 RESEARCH ON STRIP-MINING LAND BY THE COOPERATIVE WILDLIFE RESEARCH LABORATORY, S.I.U.

Jewell, S. R. and Haynes, R. J., Proc. Ill. Mining Inst., Ann. Meet., Springfield, Ill., 1972. pp 76-86. The Cooperative Wildlife Research Laboratory has conducted surveys of wildlife, vegetation, effects of land management and habitat improvement, land suitable for acquisition for recreation, and land surface mined prior to the first Illinois reclamation law. Results of various mining methods and soil chemistry of strip-mine spoils have also been investigated. 622 I29

### R72-29 IMPLEMENTING THE CHICAGO PRAIRIE PLAN

Kudrna, F. and Kelly, G. (The Metropolitan Sanitary District of Greater Chicago), Symp. Recycling Treated Municipal Waste Water & Sludge on Forest & Croplands, Penn. State Univ., Aug. 21-24, 1972. 6 pp. The Metropolitan Sanitary District of Chicago has developed a program of recycling sewage solids and liquid fertilizer from their waste-treatment plants. They apply the by-products to a 7000-acre tract of strip-mined land in Fulton County. The liquid fertilizer has also been used in other areas. The principle uses an area of 30,000 usable acres which act as a natural filter and collection

R72-29 (continued)

system. The liquid product is a clean flowing stream. The article describes other areas the Sanitary District is involved in either directly or by contract. A pipeline is now being planned to replace the barge system now being used. This line could accept inputs along the way. The program is envisioned as a completely integrated system for recycling usable waste products. R268

## R72-30 REVEGETATION AUGMENTATION BY REUSE OF TREATED ACTIVE SURFACE MINE DRAINAGE

Laval, F. J. and Robins, J. D. (Cyrus Wm. Rice Div. - NUS Corp.), U.S. EPA, Environ. Protection Technol. Ser. EPA-R2-72-119 (Nov. 1972). 147 pp. Two active surface-mine sites in Kentucky were evaluated to determine the feasibility of conducting a full-scale demonstration project on the use of neutralized acid mine drainage to irrigate new vegetative cover or regraded spoil banks. The site in the western coal field was chosen on the basis of water analyses and the nutrient requirements of the spoil banks. Water collection, neutralization plant and irrigation techniques were evaluated to determine the most feasible methods. Cost estimates are given. (Adapted from authors' abstract) R510

## R72-31 STRIP MINE RECLAMATION UTILIZING TREATED MUNICIPAL WASTES

Lejcher, T. R. (U.S. Forest Service), AIME Fall Meet., Birmingham, Ala., Oct. 18-20, 1972. Preprint No. 72-F-319. 14 pp. This paper discusses the use of municipal sewage sludge to treat strip-mine spoils and acid runoff. The U.S. Forest Service together with the Metropolitan Sanitary District of Greater Chicago conducted a small demonstration project at Sugar Creek, Ill., which receives very acid runoff. Four plots were laid out designed to sample subsurface runoff. Details of the analytical data are given together with determinations of biological organisms. The highly alkaline sludge neutralizes the acid runoff and reduces organic coliform to a minimum. About 192 acres of strip-mined land will be used for a pilot study. R472

## R72-32 RESTORATION OF ACID SPOIL BANKS WITH TREATED SEWAGE SLUDGE

Lejcher, T. R. and Kunkle, S. H., Proc. Conf. Recycling Treated Municipal Waste Water Through Forest and Cropland, University Park, Pa., by Pa. State Univ., Aug. 21-24, 1972. pp 185-199. The preliminary results of the strip mine reclamation demonstration project in southern Illinois are reviewed. A treatment of 304 metric tons per hectare, the heaviest application used, improved soil pH, allowed establishment of vegetation, reduced acidity and concentration of some of the chemicals in the runoff. R566

R72-33 COAL MINING VS. ENVIRONMENT: A RECONCILIATION IN PENNSYLVANIA

Maneval, D. R. (Appalachian Regional Comm.), Appalachia 5 (4), 10-40 (1972). Both bituminous and anthracite strip mining are included in this discussion of the environmental problems of coal mining in Pennsylvania and what is being done about them. R458

R72-34 pH AND SOLUBLE Cu, Ni AND Zn IN EASTERN KENTUCKY COAL MINE SPOIL MATERIALS

Massey, H. F., Soil Science 114 (3), [illegible]17-221 (1972). On the basis of studies with 4 spoil materials, the effects of liming on solution concentrations of Zn, Cu and Ni can be roughly estimated from pH measurements. More accurate estimates could be obtained by making a few determinations on each spoil material. Of the 3 elements studied, Ni appeared to be most likely to remain in the soil solution in toxic amounts once the pH has been adjusted to a point which would otherwise be satisfactory for plant growth. (From author's summary) 72-84

R72-35 COPPER, NICKEL AND ZINC RELEASED FROM ACID COAL MINE SPOIL MATERIALS OF EASTERN KENTUCKY

Massey, H. F. and Barnhisel, R. I., Soil Sci. 113 (3), 207-212 (1972). Seven samples of spoil material were water leached. The samples were given five successive extractions followed by subsequent leaching. The chemical results are tabulated as metal ions removed. Over a period of 35 weeks the extract of a given material was found to follow one of three patterns: a continued decrease, a decrease followed by an increase, or a continued increase. Appreciable amounts of Cu, Ni, and Zn will be found in coal mine spoils. There is no evidence as to whether these elements contribute to failure or poor growth of plants. An extensive discussion is included on the presence and effects of many ions in soil and water. R332

R72-36 MASSIVE RECLAMATION PROGRAM INITIATED

Green Lands 2 (1), 2-4 (1972). The activity, policies, and practices of the West Virginia Surface Mining & Reclamation Association and its accomplishments to date are described. A reclamation fund supported by the mining companies now makes it possible to reclaim more land per year than is disturbed. In 1971, this fund provided over $300,000 for reclamation work. R115

R72-37 MINED LAND REDEVELOPMENT--AN ACTION PROJECT BY THE MINERAL RESOURCES TASK GROUP

Kansas Geol. Surv. and Ozarks Reg. Comm., March 1972. (3 pp). The program for reclaiming southeast Kansas lands is outlined. The listing of the Mineral Resources Task Group gives the addresses of each member. R44

R72-38 STRIPPING METHODS, INCLUDING ADVANCED STRIPPING

Moolick, R. T. and O'Neill, J. E., in "Surface Mining," E. P. Pfleider, Ed., New York: AIME Seeley W. Mudd Ser., 1968, Reprinted 1972. pp 166-183. This chapter describes strip-mining practices and methods and explains all variations of handling equipment. Design of open pits and quarries is treated in detail. A general discussion on reclamation is found at the end of the article. This section emphasizes the importance of reclamation in the future and points out several problems in conservation work, and that the industry cannot afford to neglect this phase of mining. 622 P531

R72-39 NATIONAL LAND USE POLICY: BACKGROUND PAPERS ON PAST AND PENDING LEGISLATION AND THE ROLES OF THE EXECUTIVE BRANCH, CONGRESS AND THE STATES IN LAND USE POLICY AND PLANNING

Rept. to Comm. Int. Insular Affairs, U.S. Senate, 92d Congress, 2d Session, April 1972. 212 pp. Mining and reclamation of mined lands are concerns in developing a national land use policy. The summary of testimony before the committee in 1970 and 1971 is included. R440

R72-40 HEALING WOUNDS

Nephew, E. A., Environment 14 (1),12-21 (1972). The strip-mining reclamation policy in West Germany, where the author visited the Rhineland Brown Coal Fields, is well organized, and is planned well in advance of actual mining. In some cases, populated areas must be relocated. A certain portion of reclaimed land must be restored to agricultural use. A Brown Coal Committee reviews all plans and makes the final recommendation of mining and reclamation plans to be adopted. R355

R72-41 SURFACE MINING AND LAND RECLAMATION IN GERMANY

Nephew, E. A., Natl. Sci. Found. Environ. Program, Oak Ridge Natl. Lab., ORNL-NSF-EP-16, 1972. 105 pp. This report describes the restoration methods used in West Germany. Since about 55 billion tons of brown coal (or lignite) lie in the populous Rhineland coal field, whole villages have to be relocated. Before mining begins, detailed reclamation plans are worked out and include the topography, water drainage system, lakes and forests and the intended land-use pattern. R349

R72-42 NEW MINING METHODS BEING DEVELOPED

Green Lands 2 (1), 8-9 (1972). The "haul back" method of strip mining on steep slopes, developed by Grafton Coal Company, is described. R117

R72-43 1972 MINED LAND WORKSHOP PROCEEDINGS

Kansas Geol. Surv., Special Distribution Publ. 65 (1972). 29 pp. Papers presented at the workshop include: Boyce, L., "Results of soil stabilization tests with fly ash and calcium sulfate sludge," pp 3-6; Jurgens, L., "Suitable plant materials for various uses on reclaimed mined land in southeast Kansas," pp 7-9; Stewart, E. L., Jr., "Mined land redevelopment as a demonstration. Where do we go from here?" pp 9-11; Edwards, J., "The leisure industry in its total concept," pp 11-14; Geyer, W. A., "Mined land potential for raising timber crops," pp 18-21; Camin, K. Q., "Data collected from the demonstration sites," pp 21-23; McClain, T. J., "Preliminary results of hydrologic studies in southeastern Kansas coal fields," pp 24-26; Kovacic, W. J., "The use of fly ash on the acid soil of reclaimed mined land," pp 26-27; Immich, C., "Metal recovery from coal ash to defray costs of mined land reclamation," pp 28-29. There is also a map of selected reclamation sites in Kansas. R43

R72-44 PEABODY LOOKS AT THE FUTURE OF SURFACE COAL MINING

Mining Eng. 24 (10), 53-56 (1972). This is a general discussion of surface mining for coal with particular emphasis on the future trends in the markets and costs of industry operations. R101

R72-45 LEACHATE QUALITY FROM ACIDIC MINE SPOIL FERTILIZED WITH LIQUID DIGESTED SEWAGE SLUDGE

Peterson, J. R. and Gschwind, J., J. Environ. Qual. 1 (4), 410-412 (1972). This paper reports a method of upgrading acid mine spoil leachate by the addition of liquid digested sludge. The pH was raised immediately from 2.5 to 4.6. Sludge was mixed with leachate, and there was an immediate increase in pH of 4.5 with an eventual increase to pH 8. Tabulated analytical data show the changes in chemical elements. It was concluded that successful establishment of plant growth on acidic spoils would necessitate incorporation of the sludge throughout the root zone. The experiments were conducted in plexiglass columns. The columns were leached 110 days, and leachate samples were collected daily. 72-91

R72-46 EXPERIMENTATION WITH MULCHES AND SOIL STABILIZERS

Plass, W. T., Green Lands 2 (1), 30-32 (1972). A testing program was carried out by the U.S. Forest Service for the West Virginia Department of Natural Resources and West Virginia Surface Mining and Reclamation Association. Seven mulches and eleven soil stabilizers were evaluated for effect on vegetative growth and sediment yield. Results of treating a number of plots with the materials alone and in combination are discussed, and problems of handling various materials are pointed out. Several treatments were effective. R121

### R72-47 FERTILIZATION TREATMENTS INCREASE BLACK LOCUST GROWTH ON EXTREMELY ACID SURFACE-MINE SPOILS

Plass, W. T., Tree Planters Notes 23 (4), 10-12 (Nov. 1972). This project was conducted in London, Kentucky where the Lily coal seam had been mined. The spoils were low in pH--a range of 2.9 to 4.2 A number of experimental sections were planted with locust trees and using various soil treatments. A graph of the growing results shows how effective the fertilizing mixtures were. This evidence indicates that intensive fertilization will reduce locust growing time on extremely acid soils. R257

### R72-48 A NEW LAW FOR AN OLD PROBLEM

Preate, E. D., Jr., Appalachia 5 (4), 41-53 (1972). Pennsylvania's Surface Mining Conservation and Reclamation Act of 1971 is discussed, with emphasis on how it deals with environmentalists' concerns on returning the land to "productive use" after strip mining. R459

### R72-49 PROTOTYPE NATIONAL MINED-LAND INVENTORY MAP

Earth Satellite Corp., Washington, D.C., 1972. This 1:250,000 scale base map was prepared from near infrared imagery acquired in Oct. and Nov. 1972, in the area of Vincennes, Indiana. Land area affected by surface and/or subsurface mining, coal preparation plant sites, and refuse areas. R9

### R72-50 RECLAMATION MAN - JIM WHITE MAKES IT HAPPEN

Green Lands 2 (1), 5-7 (1972). This is the story of the reclamation program of the Pittston Group, by Jim White, Manager of Reclamation. Several pictures show revegetated areas. Mr. White inspects his reclaimed areas about three times a month. He points out a superintendent now must be a surface miner, an engineer, a farmer, a forester, and an educator to his employees. R116

### R72-51 COAL MINING

Reilly, J. D., in "Surface Mining," E. P. Pfleider, Ed., New York: AIME Seeley W. Mudd Ser., 1968, Reprinted 1972. pp 821-848. This chapter discusses all the phases of surface coal mining and includes a section on reclamation. Comparison is made between earlier reclamation efforts and the present practice. Emphasis is placed on the fact that many areas must design their own reclamation policies to fit their individual circumstances. The policy statement of the Mined-Land Conservation Conference, a voluntary organization of surface mine operators, is included. Water conservation is explained as a very important phase of reclamation. 662 P531

R72-52 REVEGETATE STRIP-MINED LAND

U.S. Dept. Agr., Northeastern Forest Expt. Sta., Forestry Science in the Service of Man, No. 15 (undated). 4 pp. The latest approach to revegetation is first to stabilize the spoiled land, curb erosion by planting grasses and legumes and finally plant trees. The object is to return the land to some productive use as quickly as possible. Research has shown that suitable ground cover can be established on most surface mine spoils. Emphasis now is on speeding up the whole process. Fertilization is the most important first step. Hybrid poplars are a rapidly growing tree which can be planted as uprooted cuttings. R256

R72-53 REVEGETATION OF STRIP MINED LAND - CASE STUDY, USIBELLI COAL MINE INC., ALASKA

Nuera Reclamation, Delta, B. C., Canada (undated). (16 pp). The reclamation work was turned out at the Usibelli Coal Mine near Mt. McKinley and 200 miles north of Anchorage, Alaska, during 1971-72. This booklet contains a series of original color photographs together with a short description of the project. R5

R72-54 DESIGN CRITERIA OF MINED LAND RECLAMATION

Riley, C. V. (Kent State Univ.), SME Fall Meet., Birmingham, Ala., 1972. 72-B-309. 19 pp. Criteria essential to insuring successful mined-land reclamation must include a knowledge and appreciation of the significance of the geochemistry of the overburden, spoil placement grading for proper topography and spoil surface, all relative to improved site conditions necessary for the successful establishment of vegetation, spoil stabilization, erosion control and water management. (From text) R452

R72-55 STRIP MINE LAND RECLAMATION PLANNING PROJECT

Rossin, A. D., Zimmerman, R. E., and Carter, R. P., Argonne National Lab., Cent. Environ. Studies, Preliminary Proj. Plan Rept., July 19, 1972. 23 pp; Proj. Plan and Progr. Rept., ANL/ES-17 Draft, Sept. 15, 1972. 60 pp. The objective of this project is to develop a long-range plan for reclamation of pre-law strip-mine land in Illinois. The plan development will concentrate on the environmental impact and economic consequences of proposed land reclamation schemes. A viable land use plan or set alternative plans for evaluation will stress local concerns as well as state-wide considerations. A limited program of demonstration projects is being developed. This progress report presents the tasks to be performed, the project plan, the task force participants and a set of trip reports documenting preliminary visits by the project team. (From authors' summary) R196

## R72-56 LAND RECLAMATION

Sawyer, L. E. and Crowl, J. M., in "Surface Mining," E. P. Pfleider, Ed., New York: AIME Seeley W. Mudd Ser., 1968, Reprinted 1972. pp 247-266. This chapter has sections as follows on the subject of reclamation: adapting reclamation to the site; grass and pasture planning; development as range land; reforestation; site requirements; early plantings a valuable guide; recreation; grading sites; grading reduces infiltration rate; grading reduces tree survival and growth; grading for forage crops and cultivation; grading costs vary; and the strike off grading method. State laws and their effects are discussed including average per acre costs in the various states. Other phases of reclamation discussed include special land uses. A final section discusses the outlook for reclamation, the significant amounts of money spent by the industry to date, and the need for sound policies in the coal mining areas. 622 P531

## R72-57 A STUDY OF SURFACE COAL MINING IN WEST VIRGINIA

Schmidt, R. A. and Stoneman, W. C., Stanford Research Institute Final Report to West Virginia Legislature Joint Comm. Government & Finance, Feb. 1972. 180 pp. The report covers all phases of surface mining but it emphasizes special problems of reclamation and enforcement of West Virginia's Surface Mining and Reclamation Laws. In each of these sections, water control and drainage regulations and permits are discussed. Special problems included lands which had been overstripped or have never been permitted, or are in need of some protective cover. Of particular interest are lands which are apparently outside of company bond and are now responsibility of the state. The history of enforcement in West Virginia is discussed in detail including the item of a special reclamation tax. Reclamation standards are discussed, including drainage systems. R325

## R72-58 COST OF RECLAMATION AND MINE DRAINAGE ABATEMENT, ELKINS DEMONSTRATION PROJECT

Scott, R. B., Wilmoth, R. C., and Hill, R. D., Trans. AIME 252, 187-193 (1972). A cost breakdown is given for reclamation and mine drainage abatement conducted by the FWQA, now EPA, demonstration project near Elkins, West Virginia. Costs for construction of control measures have been developed and include backfilling strip mines, sealing subsidence areas, reconstructing stream channels and installing mine seals to prevent the entrance of water and air. The two areas involved included Roaring Creek and Grassy Run which were discharging over 12 tpd of acid into the Tygart River. The control measures used are outlined, water quality characteristics are tabulated as well as the reclamation work performed. Detailed cost analyses and breakdowns are included in tabulated form. Stability of the reclaimed area has been exceptional as only eight small subsidence holes have occurred since 1967. Total maintenance costs have been less than $2,000 in the past three years or less than .03 percent per year of the construction cost. R67

### R72-59 AN ANALYSIS OF STRIP MINING AND LOCAL TAXATION PRACTICES

Seitz, W. D., Ill. Agr. Economics, Jan. 1972. pp 23-30. Information from eight selected counties in Illinois was studied in order to evaluate the effect of strip mining on land value and assessments. Although the data are considered too limited for estimating the impact of mining on the tax base, requirements for reclamation are seen as increasing land values and having the effect of assessing social costs of mining. R585

### R72-60 A SELECTED BIBLIOGRAPHY AND DISCUSSION OF THE EFFECTS OF STRIP MINING UPON NAVIGABLE WATERS AND THEIR TRIBUTARIES

Grad. Center for Public Works Admin., Univ. Pittsburgh, for Corps of Engineers, U.S. Dept. Army, 1972. 94 pp. NTIS, AD-749 802. The emphasis of this review of the literature is on the sedimentation and acid mine drainage attributable to strip mining for coal. The effects of other types of surface mining are briefly reviewed. R59

### R72-61 SELECTION OF A STRIPPING METHOD: A CASE STUDY - GOONYELLA MINE

Simchuk, G. J., AIME Trans. 252 (1), 249-253 (1972). This Goonyella mine is located in Queensland, Australia where it will be necessary to remove 43.0 million cu yd/yr to uncover 4.0 million tons of coal/yr. Experimentation with several draglines and different bucket sizes led to the use of a 50-cu-yd bucket at an effective spoil radius of 240 ft. Sketches show how the material handling is done. After much trial and error, material handling equipment specifications were developed for two draglines using 40-cu-yd and 54-cu-yd buckets respectively. Bucket capacities were calculated, and it was decided to buy 4 draglines which would do the job on a most practical basis. R259

### R72-62 MUNICIPAL WASTE WATER AIDS REVEGETATION OF STRIP-MINED SPOIL BANKS

Sopper, W. E. and Kardos, L. T., (Pa. State Univ.), J. Forestry 70, 612-615 (Oct. 1972). Sewage effluent and liquid digested sludge were used to treat spoil from stripping Lower Kittanning bituminous coal seam in Clearfield County, Pennsylvania. Some 250 tons of the extremely acid (pH 2.0 to 3.0) spoil material were treated. In the years of the program no vegetation survived on the control plot (untreated). In all treated plots, growth was good the first year and better the second year. Since the sewage material is quite alkaline (6.8 - 7.2 pH) it is a good neutralizer and it contains many mineral constituents. Details of the treatments are given and much information is included on the various plants, trees, shrubs, and grasses which were used on the project. R2

R72-63 STEEPLY PITCHING SEAMS CHALLENGE ALABAMA STRIPPING

Coal Mining Process. 9 (10), 50-53 (1972). This account describes the strip-mining operation of the Burgess Mining & Construction Corp. in central Alabama. A number of different seams outcrop in the two fields being worked so the company uses many different types of equipment and maintains a number of separate pit operations. Their reclamation program is described. R100

R72-64 HYDROLOGIC INVESTIGATIONS OF SMALL WATERSHEDS IN OHIO.
PHASE II: 1969-1972

Taiganides, E. P. and Ricca, V. T. (Ohio State Univ., Water Resour. Center), Office Water Resour. Res., U.S. Dept. Int. Completion Rept., Proj. No. 342X (undated). 111 pp. In the watershed areas of Little Mill Creek and the USDA North Appalachia Experimental Watersheds near Coshocton, Ohio, the Stanford Streamflow Model (simulation) was used to obtain the infiltration component of the hydrologic cycle and to solve the equations of flow over an infiltrating watershed. The Alternating Direction Implicit (ADI) method was used effectively to model a two-dimensional completely saturated and completely unsaturated flow. In comparing a strip-mined area to an agricultural area, spoil banks were found to be stabilizing and there was no significant difference in percent of direct runoff and percent of total yield of water during selected intense storms. R146

R72-65 BROWN COAL MINING IN WESTERN GERMANY

Tilmann, W., in "Surface Mining," E. P. Pfleider, Ed., New York: AIME Seeley W. Mudd Ser., 1968, Reprinted 1972. pp 955-968. The large-scale operation of brown coal mining includes continuous reclamation. The seam is followed and any man-made obstacle such as villages and farms are removed and relocated. The mining operation, the equipment used, and the costs incurred are discussed in detail. 622 P531

R72-66 PRODUCTION ENGINEERING IN SURFACE COAL MINES

Weimer, W. H., in "Surface Mining," E. P. Pfleider, Ed., New York: AIME Seeley W. Mudd Ser., 1968, Reprinted 1972. pp 224-246. This chapter covers stripping broadly and includes overburden handling. Numerous sketches are included to show the details of box cut and bench methods. Advance stripping is explained and the significance of optimum rates. The importance of good drainage is stressed and the use of diversion dams and the value of dewatering methods to be used in the working pits are shown. Detailed calculations show how production and operating costs are figured. 622 P531

R72-67 SOME ASPECTS OF OPENCAST COAL MINING IN SOUTH WALES

Whincup, G. T., Proc. South Wales Inst. Eng. 86 (1), 15-33 (1972). "Restoration" is one of the considerations of this general discussion. Methods of

R72-67 (continued)

reclaiming land to agriculture or forestry use are described. R347

R72-68 SURFACE MINING AND RECLAMATION IN KENTUCKY/1972

Beach, B. A., Kentucky Division of Reclamation (undated). 48 pp. This brochure summarizes the coal resources of Kentucky, the problems resulting from extraction by surface mining, methods and results of reclamation, and requirements of Kentucky mining laws. R774

R72-69 NEW TECHNIQUES FOR REVEGETATING STRIP-MINED AREAS

Bennett, O. L. (1), Jones, J. N., Jr. (2), Armiger, W. H. (3), and Lundberg, P. E. (1) [Agricultural Research Service, U.S. Department of Agriculture (1) Morgantown, W. Va. (2) Blacksburg, Va. and (3) Beltsville, Md.], Soil Conservation Society of America, 27th Annual Meeting Proceedings, Portland, Oregon, Aug. 6-9, 1972. pp 50-55. This report of a cooperative research program between the U.S. Department of Agriculture and Virginia Polytechnic Institute and State University covers the use of raw rock phosphate on acid spoil; the identification of plants, particularly bermudagrass species, which can tolerate low pH and high amounts of iron, aluminum, and manganese; the use of small grains and summer annual species as quick cover and onsite mulch; the use of stairstep ledges for seeding slopes; research on encouraging legume growth on acid spoils; and the use of sewage sludge, fly ash, and other waste materials as fertilizers and mulch while avoiding the problem of toxicity from the relatively high concentrations of heavy metals in these sources. CE419

R72-70 STRIP MINE RECLAMATION: CROWNVETCH FOR SPOIL BANKS

Brusca, H. J. and McKee, G. W., Green Lands 1 (3), 18-19 (Spring 1972). Crownvetch and the characteristics which make it an excellent plant to stabilize slopes are described. Lime and mulch are recommended for establishing crownvetch on spoil banks. R812, Jour

R72-71 PALZO: A PROJECT IN ACID LAND AND WATER RESTORATION VIA RECYCLING OF TREATED WASTES

Hendricks, C. (U.S. Forest Service, Shawnee National Forest, Harrisburg, Illinois), Soil Conservation Society of America, 27th Annual Meeting Proceedings, Portland, Oregon, Aug. 6-9, 1972. pp 66-69. The success of the demonstration project using sewage sludge on four small plots has led to plans for a larger project on 150 acres of the Palzo site, a strip-mined area in southern Illinois. It is expected that the same improvement in water quality, establishment of vegetation, and lack of adverse effects from the sludge will result from the application of sludge to the Palzo site where the pyrite-containing spoil causes highly acid runoff. CE422

### R72-72 A BIBLIOGRAPHY OF SURFACE COAL MINING IN THE UNITED STATES TO AUGUST, 1971

Kieffer, F. V., Forum Associates, 1364 B North Hague Street, Columbus, Ohio 43204 (1972). 71 pp. The more than 400 entries are arranged in ten categories which indicate the type of material such as theses and dissertations or government publications. The index includes authors and titles. 72-51

### R72-73 RECOVERY OF MINED LAND

Krause, R. R., Coal Mining Process. 9 (1), 51-56 (1972). This survey of the latest techniques includes control of runoff from rainfall, acidity determination for soils, special planting tools, and species suitable for planting on mined land. Jour

### R72-74 SOME ASPECTS OF SOIL NUTRIENTS IN SPOILBANKS OF A SOUTHERN ILLINOIS STRIPMINE

McGrath, J., M.S. Research Report, Southern Illinois University, 1972. 82 pp. In order to evaluate the difference between clay and shale spoils, and to determine the effects of aging, including the effects of weathering on nutrients at selected depths of shale spoil, 180 soil samples collected from the Will Scarlet Mine were analyzed for pH, nitrate, ammonia, potash, calcium, magnesium, phosphate, sulfate, chloride, total soluble salts, iron, manganese, aluminum, copper, zinc, boron, and molybdenum. Among the conclusions were that generally clay spoils had nutrients similar to those found in undisturbed soil, while shale spoils were very acid and tended to have toxic amounts of several nutrients. Aging was evident in the shale, while the one-week to two-year old clay spoil was judged not to have had sufficient time to exhibit aging processes. Deposits of refuse from mined coal and slurry from coal cleaning were also examined. Deposits more than four years old were very acid. R948

### R72-75 MINING GUIDEBOOK: SURFACE MINING: RECLAMATION

Coal Age 77 (7), 181-182 (1972). This overview discusses reclamation planning, research showing that ungraded lands absorb rainfall more readily than graded land, suitable plants and seeding and planting methods for reclaimed land, erosion control, and use of reclaimed land. Jour

### R72-76 COAL STRIP-MINED LAND IN INDIANA

Powell, R. L., Indiana Geological Survey, Special Report 6 (1972). 18 pp. Mined land is identified and enumerated by county, and the geology of the coal beds in the state is described. Much reclamation has been carried out and has varied from plantings on spoil banks to development of public recreation areas and productive farm land. R873

R72-77 ATTITUDE TOWARD SURFACE MINING FOR COAL AND RECLAMATION IN OHIO: A SPATIAL ANALYSIS

Ray, J. R., Ph.D. Thesis, The Ohio State University, 1972. 231 pp. University Microfilms, 73-2101. There were no significant variations in attitudes toward surface mining in populations of varying social status or between populations residing in areas of mining activity and in areas with no mining. However, it was found that as social status increased, attitudes toward reclamation became more positive, and also that there was a significantly more positive attitude toward reclamation by populations living in mining areas than by populations living outside of mining areas. 631 R26

R72-78 STUDY OF STRIP-MINE SPOILS BELMONT AND NOBLE COUNTIES, OHIO

U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Staff, Columbus, Ohio, June 12-15, 1972. 39 pp.+ Detailed studies were made of spoil at 10 sites to aid in developing an improved spoil classification system. R905

R72-79 SURFACE MINE RECLAMATION

Teague, R. N., Outdoor Indiana 37 (8), 26-29 (Oct. 1972). The author reviews the requirements of the 1941 and 1967 legislation and the 1972 revision of the earlier guidelines for reclamation. R913

## 1973

R73-1 HYDROLOGY OF A WATERSHED CONTAINING FLOOD-CONTROL RESERVOIRS AND COAL SURFACE-MINING ACTIVITY, SOUTHWESTERN INDIANA

Agnew, A. F. and Corbett, D. M. (Ind. Univ.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper II-3. pp 159-173. Hydrologic studies of Busseron Creek watershed are reported. Monitoring water quality during normal, high, and low flow and during "flush out" has shown the major effect on chemical quality of flushouts. 631 H981

R73-2 SURVIVAL AND GROWTH OF RED PINE ON COAL SPOIL AND UNDISTURBED SOIL IN WESTERN PENNSYLVANIA

Aharrah, E. C. (1) and Hartman, R. T. (2) [(1) Clarion State College, Pa. (2) Univ. Pittsburgh], in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper IV-3. pp 429-444. Comparisons were made of 20-year-old red pine plantations growing on spoil of Kittanning coal and on an adjacent undisturbed field in Clarion County, Pa. The old-field plantation shows greater growth in five different parameters, but the red pine is shown to have grown very well on the spoils, and compares quite well in many parameters with those reported in the literature. Percentage survival is higher on the spoil than

R73-2 (continued)

in the old-field situation. Some measurements of red pine growing on Clarion coal seam spoil are also reported. (From authors' abstract) 631 H981

### R73-3 MAPPING OF SPOIL BANKS USING ERTS-1 PICTURES

Ahmad, M. U. (1), Kantner, D. A. (1), and Antalovich, J. W. (2) [(1) Ohio Univ. (2) Kucera and Associates, Inc.], Symp. Significant Results Obtained from Earth Resour. Tech. Satellite-1: Vol. 1 Tech. Presentation, Sec. B: Natl. Aero. Space Admin. Rept. NASA SP-327 (1973). pp 1575-1582. Four pictures of different wave lengths (MSS 4, 5, 6, 7) were used in the study of two strip-mine areas in southeastern Ohio, one near Piedmont Lake and the other near New Lexington. The gray tone of 9.5 inch prints examined under a binocular microscope were correlated with actual ground conditions at several sites. For the New Lexington area, color infrared pictures taken at an elevation of 18,000 feet were also used for correlation with the ERTS-1 imagery. The results indicate that MSS 5 and 7 are most useful in defining the stripped land and show that the hydrological and soil characteristics are remarkably different from the surrounding lands. (From authors' abstract) R575

### R73-4 REVEGETATING DISTURBED AREAS IN THE SEMIARID SOUTHWEST

Aldon, E. F., J. Soil Water Conserv. 28 (5), 223-225 (1973). Fourwing saltbush and alkali sacaton, plants native to the area, have been used in a 20-year watershed rehabilitation project. Methods of growing transplants and field planting are described. Since vegetation is naturally light, planting results of 25 percent ground cover of perennial vegetation is considered excellent. R346

### R73-5 THE USE OF ERTS-1 MSS DATA FOR MAPPING STRIP MINES AND ACID MINE DRAINAGE IN PENNSYLVANIA

Alexander, S. S., Dein, J., and Gold, D. P. (Pa. State Univ., Office Remote Sensing Earth Resour.), Symp. on Significant Results Obtained from Earth Resour. Tech. Satellite-1: Vol. 1 Tech. Presentation, Sect. A: Natl. Aero. Space Admin. Rept. NASA-SP-327 (1973). pp 569-575. The use of digital processing of ERTS-1 MSS data for areas around the West Branch of the Susquehanna River permits identification of stripped areas including ones that are not discernible from visual analysis of ERTS-1 imagery. Preliminary results indicate that ERTS data can be used to monitor not only the extent of stripping in given areas but also the effectiveness of reclamation and pollution abatement procedures. 73-69

R73-6 EXPERIMENTAL MULTIPLE SEAM MINING AND RECLAMATION ON STEEP MOUNTAIN SLOPES

Allen, N., Jr. (TVA), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 98-104. The stripping method developed was tested in an actual coal production area where four seams could be stripped and augered. Spoil was placed only on outslopes of 28 degrees or less in an area limited to 20 feet vertically below the coal elevation. Excess spoil was hauled to a previously mined pit at another nearby site. As stripping and augering progressed, overburden removed from a higher seam was used for fill in the vacated pit. The final slope was graded to approximately 1.5/1 and the reclaimed area hydroseeded as quickly as possible. A 30-foot bench on the outer slope was kept clear of spoil for a roadway for future mining. Some of the problems of spoil handling are discussed, and preliminary trucking costs are given. R639

R73-7 ANALYSIS OF POLLUTION CONTROL COSTS

Michael Baker, Jr., Inc., Rept. to Appalachian Regional Comm., Feb. 1973. 436 pp.+ The purpose of this publication is to provide data which will enable the Commission to estimate costs of pollution abatement in the Monongahela River Basin. Pollution both from coal mining and from non-coal sources is considered. Abatement methods discussed include mined-land reclamation and revegetation. Detailed costs are given for a number of recently completed projects. R112

R73-8 STATEMENT BEFORE SUBCOMMITTEE ON PUBLIC LANDS, U.S. SENATE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS

Bagge, C. E. (President, Natl. Coal Assoc.), March 1, 1973. 9 pp. The National Coal Association position on proposed S.424 and S.1041, National Resource Lands Management Legislation, is presented. R1

R73-9 ECOLOGICAL AERIAL PHOTO INTERPRETATION FOR REVEGETATION IN THE COLOGNE LIGNITE DISTRICT

Bauer, H. J. (Tech. College Aachen, Ger.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VII-9. pp 469-476. Information available from aerial photos is discussed and an aerial photo of the Cologne Lignite District is shown. 631 H981

R73-10 TEN YEARS' STUDIES OF BIOCENOLOGICAL SUCCESSION IN THE EXCAVATED MINES OF THE COLOGNE LIGNITE DISTRICT

Bauer, H. J. (Technical College, Aachen, West Germany), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York:

R73-10 (continued)

Gordon and Breach, 1973. Paper III-2. pp 271-283. Results of studies of the rapidly changing landscape have disclosed laws of plant associations and succession which are of great value in the reclamation of excavated mines. (From author's abstract) 631 H981

R73-11 STRIP MINING AND RECLAMATION IN KENTUCKY/1972

Beach, B. A. (Ky. Dept. Natl. Resour., Div. Reclamation), Ind. Coal Conf., Univ. Ky., April 12-13, 1972. 6 pp. (Date corrected from previous edition) This paper reviews the background of mining in Kentucky and discusses specifically the impact of strip mining on the environment. In 1966 the General Assembly passed a strip-mining law. This article outlines the programs conducted in cooperation with Appalachian Regional Commission and the U.S. Environmental Protection Agency, U.S. Corps of Engineers, U.S. Forest Service and the U.S. Soil Conservation Service. The article also describes how the Kentucky Reclamation Division enforces the law, levies penalties and issues permits. Detailed figures are given on strip-mined acreage explaining the great growth of this industry in Kentucky, the number one coal-producing state. 662.6 I42

R73-12 USE OF FERTILIZERS TO SPEED PINE ESTABLISHMENT ON RECLAIMED COAL-MINE SPOIL IN NORTHEASTERN ALABAMA: I. GREENHOUSE EXPERIMENTS

Bengtson, G. W., Allen, S. E., Mays, D. A., and Zarger, T. G. (TVA), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VI-6. pp 199-225. These investigations indicate that properly timed application of appropriate N-P fertilizers to planted or newly seeded pine or pine-grass mixtures is the key to rapid establishment of a desirable vegetative cover on this and similar sites. (From authors' abstract) 631 H981

R73-13 REVEGETATION OF COAL SPOIL IN NORTHEASTERN ALABAMA: EFFECTS OF TIMING OF SEEDING AND FERTILIZATION ON ESTABLISHMENT OF PINE-GRASS MIXTURES

Bengtson, G. W., Mays, D. A., and Allen, J. C. (TVA), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. 1973). pp 208-214. The study plots, all seeded to loblolly pine at the start of the test, were set up to include controls and all combinations of the following variables: seeding with combinations of three grasses; fertilization at three rates and two different times; and seeding and grading at two different times. Results of the three-year study showed that objectives of revegetation should determine the reclamation plans. For example, where grasses and pines were seeded together, pine seedlings have difficulty surviving. Where pine was seeded alone, there seemed to be better germination and survival in the freshly-graded block because better seed-bed conditions existed. Also where pine was seeded alone, fertilizer

R73-13 (continued)

treatment had no effect in seedling germination and survival through the first growing season. Fertilization enhanced the growth of grass and the later growth of trees. R648

### R73-14 EVALUATION OF P AND K SOIL FERTILITY TESTS ON COAL-MINE SPOILS

Berg, W. A. (Northeastern Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper I-8. pp 93-104. Greenhouse studies were carried out to determine plant-available P and K in southern Appalachian coal-mine spoils. Results showed that soil tests will not necessarily predict plant growth on spoils. 631 H981

### R73-15 COMPOSITION AND PRODUCTION OF SEEDINGS ON STRIP-MINE SPOILS IN NORTHWESTERN COLORADO

Berg, W. A. and Barrau, E. M. (Colo. State Univ.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 215-224. Alfalfa dominated vegetation on strip mine spoils in northwestern Colorado (6600 to 7600 feet elevation, 16 to 18 inches average annual precipitation) seeded two to eight years previously with a mixture of grasses and legumes. Dry matter production on spoils and soil-covered spoils was comparable when alfalfa was the dominant species. Dry matter production was greater on spoils where alfalfa was the dominant species than on soil-covered spoils where smooth bromegrass and wheatgrasses were the dominant species. Total nitrogen in the soil size fraction of the spoils ranged from 545 to 1205 ppm N as compared to 2700 ppm for surface soils in the area. The spoils contained about 70 percent coarse fragments and possibly have a more favorable moisture regime for growth of deep-rooted plants than the moderately fine to fine-textured soils common to the area. (Authors' abstract) R649

### R73-16 TOXICITY OF ACID COAL-MINE SPOILS TO PLANTS

Berg, W. A. and Vogel, W. G. (Northeastern Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper I-5. pp 57-68. Manganese and aluminum toxicity to herbaceous legumes, shrub lespedezes, and black locust was assessed in greenhouse and field trials using extremely acid spoils. 631 H981

### R73-17 GRAFTON'S HAULBACK STRIP METHOD HAS MANY ADVANTAGES

Blakely, J., Coal Mining Process. 10 (7), 46-49 (1973). This article describes a new method of surface mining that reduces the disturbed acreage by two-thirds. The method, developed by C. E. Compton, president of Grafton Coal Co., consists of hauling the overburden from the bench and backfilling

R73-17 (continued)

the mined-out pit immediately behind the operation. No spoil is placed over the outslope and the highwall is eliminated. Water control is improved and much of the fast runoff that causes siltation is prevented. R88

## R73-18 LAND RECLAMATION FOLLOWING MINING

Brooks, D. B. and Williams, R. L., in "SME Mining Engineering Handbook," Vol. 2, A. B. Cummins and I. A. Given, Eds., New York: AIME, 1973. pp 19-12 - 19-16. This section discusses site preparation, backfilling and terracing, and revegetation. Advice on what to do in site preparation includes items which should be buried and those which should be disposed of in some other way. Estimated cost of preparation is listed as $30 to $50/acre. The degree of backfilling depends on the mining method used and the land use intended. Grading and backfilling are discussed in detail and a number of ways to stabilize waste accumulation are included. A list of 9 guidelines for grading gives specific instructions. Revegetation is treated from the standpoint of stoniness, toxicity, and moisture of the particular area. Reforestation species are listed for various pH ranges, and many grasses, legumes and shrubs are listed for mined areas and waste piles. Specific planting methods are required for individual areas. R622 A943

## R73-19 SITE FACTORS AND SEEDING METHODS AFFECTING GERMINATION AND SURVIVAL OF TREE SPECIES DIRECT-SEEDED ON SURFACE-MINED AREAS

Brown, J. H., W. Va. Univ., Agr. Expt. Sta., Bull. 620 (1973). 25 pp. A study to investigate the effects of direction slopes faced, degrees of compaction, and vegetative cover on germination and survival of direct-seeded trees was carried out near Reedsville, Preston County, W. Va. at an elevation of 2,100 feet. The effects of different seeding methods were also compared. Moisture, temperature, and seasonal effects were also found to influence the success of tree establishment. Seedbed treatment gave good results but there was little difference between covering the seed with soil or covering plus mulching. R75

## R73-20 FISHERY MANAGEMENT IN STRIP MINE LAKES

Burner, C. C. (Fish Wildlife Serv., USDI), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 304-318. A study of ten strip-mine lakes in Kansas and six in Indiana has demonstrated that strip-mine lakes can support good quality sport fishery. Fish populations can be established in lakes that have drainage from a fairly large watershed instead of only adjacent spoil banks; have an area greater than a half an acre; have a depth of over five feet; and a pH no less than 6. Fish stocking guidelines for these waters are given and suggestions are made of combinations of species and the conditions under which they should be used. R658

### R73-21 BIG BLADE FOR A BIG JOB

Burton, L., The Orange Disc, Gulf Oil Corp. 21 (1), 10-15 (Sept.-Oct. 1973) The 40-foot-wide bulldozer angle blade used to grade strip-mined land areas is pulled by two tractors. Earth moving is considerably speeded up and reclamation costs are reduced. The demonstration of the unit at Pittsburg & Midway's McKinley Mine near Gallup, New Mexico, is described. R435

### R73-22 NATURAL REVEGETATION AND CAST OVERBURDEN PROPERTIES OF SURFACE-MINED COAL LANDS IN SOUTHERN INDIANA

Byrnes, W. R. and Miller, J. H. (Purdue Univ.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper III-3. pp 285-306. The overburden was characterized by a number of samples and tree, shrub, vine, herb, and grass species occurring on the mined land were inventoried. The authors stated, "one of the most obvious conclusions---is that with both cast overburden properties as well as vegetation cover and composition, the variation existing within an area may be as great as that existing between two or more areas of different ages." 631 H981

### R73-23 CABIN CREEK, WEST VIRGINIA STRIP MINE DEMONSTRATION RECLAMATION PROJECT

U.S. Army Eng. Dist. Huntingdon, W. Va., May 1973. 46 pp. Draft Environ. State. EIS-WV-73-1159-D. This Cabin Creek, West Virginia strip-mine demonstration reclamation project study area is the watershed of Cabin Creek, a tributary of the Kanawha River, about 20 miles upstream from Charleston. The basin is about 16.3 miles long and 4.5 miles wide. This area was studied for the effects of strip mining on the navigable rivers and their tributaries. After one year, recommendations were to be made to mitigate adverse conditions due to strip-mining practices. The report contains all the phases of the study such as mineral resources, hydrology, land use, and socio-economic features. R237

### R73-24 SOIL-MAKING POTENTIAL OF POWERPLANT FLY ASH IN MINED-LAND RECLAMATION

Capp, J. P. and Gillmore, D. W. (U.S. Bur. Mines), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 178-186. Treatment of coal waste from surface and deep mining with fly ash results in a soil cover which will sustain grasses and legumes. Among the beneficial effects of using fly ash are its ability to neutralize acidity in soil and to improve soil texture and moisture retention. Techniques of reclaiming with fly ash are discussed and the importance of thorough mixing with spoils is emphasized. Cost estimates for fly ash reclamation of strip soil and refuse banks are attractive and in some cases may be cheaper than alternative methods. One economic advantage comes from the fact that market value of materials found in fly ash has been

R73-24 (continued)

calculated to be greater than the cost of using fly ash. (Authors' abstract adapted) R645

## R73-25 STRIP MINE RECLAMATION IN ILLINOIS

Carter, R. P., Zimmerman, R. E., and Kennedy, A. S., Argonne National Laboratory, Energy and Environ. Studies Div., Rept. to Ill. Inst. Environ. Qual., Dec. 1973. (296 pp). A survey of lands affected by strip mining and by coal refuse piles before the passage of legislation requiring reclamation is the basis for a comprehensive study. Water quality data show that the Kaskasia, Big Muddy, and Saline are the major Illinois rivers in which significant mine-related pollution occurs. Water treatment costs and reclamation costs are presented. There is also an analysis of tax revenue over a number of years from representative parcels of land. 73-38

## R73-26 CHARACTERIZATION OF STRIP-MINE DRAINAGE BY PYRITE GRAIN SIZE AND CHEMICAL QUALITY OF EXISTING GROUNDWATER

Caruccio, F. T. (Univ. S. C.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper II-5. pp 193-226. The author gives evidence that grain size of pyrite is related to pyrite reactivity and acid production. By evaluating the distribution of the grain size of the pyrite in the mine strata and analyzing the chemical composition of the existing groundwaters, it is possible to outline, and consequently predict, areas which will yield highly acid-high sulfate mine drainages; moderately acid-moderate sulfate mine drainages; neutral mine drainages containing negligible amounts of sulfate (reflecting the stability of pyrite in these areas); and neutral mine drainages containing moderate amounts of sulfate (indicative of acid mine drainages that were neutralized by high alkaline waters). (From author's abstract) 631 H981

## R73-27 METHODS OF ASSESSMENT OF ACID COLLIERY SPOIL AS A MEDIUM FOR PLANT GROWTH

Chadwick, M. J. (Univ. York, U.K.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper I-7. pp 81-91. Bioassay and plant performance tests are suggested as giving better evaluation of coal mine spoil ability to support growth than soil analyses. 631 H981

## R73-28 THE CHALLENGES AND OPPORTUNITIES OF MINING WESTERN COAL

Coal Age 78 (5), 41-48 (1973). There are extensive coal deposits west of the Mississippi and plants, mining operations, and reclamation efforts are pictured. Reference is made to the reclamation program of Peabody Coal Company in which surface runoff water is diverted from final mining cuts to specific

R73-28 (continued)

areas to form reservoirs and lakes. A minimum time elapses between mining and restoration work. Much of the western coal is located in Indian areas and this situation will improve the economics of the Indian population. R342

## R73-29 SURFACE MINING OF COAL - 1972

Charmbury, H. B. (Penn.State Univ.), Mining Congr. J. 59 (2), 104-109 (1973). The status of strip mining and reclamation is reviewed. Legislative control in effect and pending is summarized. R466

## R73-30 ERTS-1 INVESTIGATION OF ECOLOGICAL EFFECTS OF STRIP MINING IN EASTERN OHIO

Chase, P. E. (1) and Pettyjohn, W. (2) [(1) The Bendix Corp. (2) Ohio State Univ.], Symp. Significant Results Obtained from Earth Resour. Tech. Satellite-1: Vol. I, Tech. Presentation, Sect. A: Natl. Aero. Space Admin. Rept. NASA SP-327 (1973). pp 561-568. Paper E2. Both enlarged ERTS imagery and statistically processed outline maps and imagery of stripped earth and standing water are compared to aerial photos of a strip mine near Coshocton, Ohio. The ERTS capability at present is limited to forming a disruption map of recently mined and unreclaimed earth and the resultant standing water within the mined area. (Authors' abstract adapted) R578

## R73-31 NEW SURFACE-MINING METHODS SIMPLIFY RECLAIMING OF SPOILS

Chironis, N. P., Coal Age 78 (4), 80-84 (1973). The new reclamation procedure developed by the Pittsburg & Midway Coal Mining Co., Kansas City, Missouri, uses a 40-ft-long blade mounted on a Caterpillar D96 crawler-type tractor, and guided by a lead tractor by means of a single-point hitch to the leading edge of the blade. The development of block method of mining is also discussed. R465

## R73-32 COAL-ENERGY DEVELOPMENT IN THE NORTHERN GREAT PLAINS

Special Advisory Comm., Water Resour. Res. Inst., Univ. Wyoming, Dec. 1973. 114 pp.+ NTIS, PB-231 560/4WE. Reclamation needs and work in progress are among the concerns summarized in this study which is a part of the Northern Great Plains Resources Program. The program is designed to provide information on the impacts of coal development on the region. 800.1 73-3

## R73-33 COAL AND THE ENVIRONMENT

National Coal Association, 1973. (13 pp). This is a generalized discussion on the relationship of coal and its problems to the overall environment.

R73-33 (continued)

Stack gas pollution, including fly ash and sulfur dioxide, is explained. Several $SO_2$ removal processes are discussed. Pictures of reclaimed strip-mined land are included, reclamation methods are discussed, and several projects described. R261

### R73-34 COAL SURFACE MINE RECLAMATION PROJECT

Coal Mining Process. 10 (10), 21 (1973). This item is a picture of a reclamation project of the Mountaineer Division of Consolidation Coal Company 12 miles west of Philippi, West Virginia along Route 57. A ten-acre hillside removed in the process of mining two seams of coal resulted in a 60-acre area of level to rolling land. R215

### R73-35 COAL SURFACE MINING AND RECLAMATION: AN ENVIRONMENTAL AND ECONOMIC ASSESSMENT OF ALTERNATIVES

Council Environ. Qual. Rept. to Comm. Int. Insular Affairs, U.S. Senate, 93d Congress, 1st Session, March 1973. 143 pp.+ This comprehensive committee report on surface mining and reclamation techniques includes information on contour strip mining, shaping of spoil banks, integrated mining and reclamation, state regulatory programs, requirements and limitations of mining, and strippable reserves. An appendix gives cost analysis of contour mining and reclamation techniques. R411

### R73-36 ANNOTATED BIBLIOGRAPHY ON THE ECOLOGY AND STABILIZATION OF COASTAL SAND DUNES, MINING SPOILS AND OTHER DISTURBED AREAS

Coaldrake, J. E., McKay, M., and Roe, P. A. (CSIRO), Commonwealth Sci. Ind. Res. Organization, Div. Plant Ind., Canberra, Australia, 1973. 158 pp. This bibliography contains 639 references on the ecology of natural and disturbed areas and on methods for re-establishing vegetation, especially after opencast mining. Reclamation of coal-mining spoils, one of the subject areas covered, contains 50 annotated references and 12 supplementary references. R496

### R73-37 LANDSCAPE ARCHITECTURAL APPROACH TO SURFACE MINING RECLAMATION

Coates, W. E. (William E. Coates and Associates, Ltd.), Natl. Coal Assoc./ Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 26-41. In the view of the landscape architect, strip mining should be considered as an interim land use and provision must be made to return mined land to the highest and best use compatible with use of adjoining land. Advantages claimed for planning rehabilitation as part of the mining operation are low cost, reducing overburden handling and equipment movement, and minimal open raw areas at any time during the mining operation. The most immediate needs for vegetative cover, preventing erosion and improving the soil, can be met best by legumes

R73-37 (continued)

and grasses. Therefore, the author suggests the use of trees only for screening exposed highwall, for visual accents, or as sources of seed for volunteer seedlings where there are no nearby mature forests. R634

R73-38 RECLAMATION COMMITMENT PROVES REWARDING

Cornforth, C. L., Coal Mining Process. 10 (3), 32-35 (1973). This article reports the progress of Amax Coal Company's reclamation program at its Sun Spot Mine, Fulton County, Illinois. The soil in this area is mostly loess and has very good chemical and physical properties. Fertilizers or soil additives are generally not needed. A number of pictures illustrate the success of this reclamation work carried out by Meadowlark Farms, Inc., which is Amax Coal's subsidiary. A large-scale beef-cattle enterprise is now being developed by Amax. There is a detailed account of the grading and seeding program. R249

R73-39 RECLAMATION PROVES SUCCESSFUL IN SEMI-ARID MONTANA

Cornforth, C. L., Coal [illegible] Process. 10 (7), 40-42 (1973). This article describes the successfu[illegible]oration at Western Energy Company's pit No. 6 in semi-arid southeastern Montana. The country around the Colstrip area was primarily grazing land with topsoil which is thin or in many areas nonexistent. The overburden is soft sandstone and shale. Topsoil is stock-piled or used immediately on reclaimed areas. Reclamation is carried out by methods developed by research of Montana State University's Agricultural Experiment Station under direction of R. L. Hodder and emphasizes "surface manipulation" to improve seed bed and moisture-retention capacity of the soil. Reclamation of old stripped areas as well as of land currently mined is planned. R87

R73-40 WESTERN ENERGY STRIPS THE 25-FT ROSEBUD IN SOUTHEASTERN MONTANA

Cornforth, C. L., Coal Mining Process. 10 (7), 36-39 (1973). In this description of the entire mining operation it is noted that topsoil is stripped from the overburden and either stockpiled or applied directly to a grading area. R86

R73-41 SPOIL TYPE LITHOLOGY AND FOLIAR COMPOSITION OF BETULA POPULIFOILA

Cornwell, S. M. (1) and Stone, E. L. (2) [(1) Sheffield Univ., U. K., (2) Cornell Univ.], in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper I-9. pp 105-120. Leaves of gray birch growing on anthracite spoil were sampled and analyzed for different elements to determine availability of plant nutrients or possible toxicity. 631 H981

### R73-42 BASIC PRINCIPLES OF SEED PLANTING

Currier, W. F. (Forest Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 225-232. The following basic principles and their application to seeding critical areas, including land disturbed by strip mining, are discussed: the use of adapted species; reduction of plant competition; preparation of a good seed bed; covering the seed to proper depth; evenness of seed distribution; proper timing for seeding; and sufficient plant nutrients for plant establishment and growth. The use of two main methods of seeding, drilling and broadcasting, is related to these basic principles. R650

### R73-43 EFFECTS OF STRIP MINING ON THE HYDROLOGY OF SMALL MOUNTAIN WATERSHEDS IN APPALACHIA

Curtis, W. R. (Northeastern Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper II-2. pp 145-157. The effects of strip mining on the water resources of small mountain watersheds are being investigated in eastern Kentucky. Six subdrainages have been instrumented to record pre-mining conditions, changes during active mining operations, and the rate of recovery after mining. Stream turbidity and peak flows increase during mining, but on one subdrainage, turbidity returned to near pre-mining condition within about 6 months after mining. Storm runoff durations apparently do not change. Sulfate and magnesium in the streamflow have increased since mining. (Author's abstract) 631 H981

### R73-44 MOISTURE AND DENSITY RELATIONS ON GRADED STRIP-MINE SPOILS

Curtis, W. R. (Northeastern Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper II-1. pp 135-144. This paper reports the first-year results of a study to determine the disposition of subsurface moisture on leveled spoil banks in western Kentucky and to determine whether the moisture conditions can be changed through scarification and vegetative treatments. (From author's abstract) 631 H981

### R73-45 ESTABLISHING FOREST ON SURFACE-MINED LAND AS RELATED TO FERTILITY AND FERTILIZATION

Czapowskyj, M. M. (Northeastern Forest Expt. Sta.), Forest Serv. Gen. Tech. Rep. NE-3, 1973. Reprinted from Forest Fertilization Symp. Proc., pp 132-139. This publication has compiled and discussed literature referring to reforestation and spoils composition. Nearly all essential elements for plant growth were found in the spoils. Planted and seeded forest trees respond strongly to application of nitrogen and phosphorus singly and in combination. Certain spoils will respond to potassium. Extreme acidity and high concentrations of Mn, Fe, Zn, S and Al are major factors limiting plant growth on coal-breaker

R73-45 (continued)

refuse, but such areas are a small portion of the total area of disturbed land. Application of lime alleviates these problems. R532

## R73-46 LAND DISPOSAL IV: RECLAMATION AND RECYCLE

Dalton, F. E. and Murphy, R. R. (Metropolitan Sanitary District of Greater Chicago), J. Water Pollut. Contr. Fed. 45 (7), 1489-1507 (1973). Strip-mine areas in Fulton County, Illinois, are identified as one of the types of land that would benefit from the Prairie Plan - a solids disposal on land program. Barge transportation is now used to transport the solids but a pipeline is planned and storage for liquid fertilizer will be used. Costs for the system are estimated and the water and atmospheric monitoring systems are described. A campaign for public acceptance is necessary for the success of the project. R213

## R73-47 GRASSES AND HERBS FOR REVEGETATING PHYTOTOXIC MATERIAL

Darmer, G. (Tech. Univ. Hannover, Ger.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper V-6. pp 91-101. The program to find vegetation suitable for marcasite containing overburden of Midgerman brown coal strip mines is described and species successfully used are noted. 631 H981

## R73-48 COMPARISON OF FALL AND SPRING PLANTING ON STRIP-MINE SPOILS IN THE BITUMINOUS REGION OF PENNSYLVANIA

Davis, G., in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper IV-9, pp 525-538. This project was done to evaluate fall versus spring planting of 10 coniferous tree species and 5 hardwood shrubs. Experimental plantings were established over a 2-year period on 7 graded strip-mine spoils. Spring planting proved more successful than fall planting and survival was better with spring-planted items than fall plantings. Shrubs survived well with both spring and fall planting especially on the better sites. Tabulated heights of trees and shrubs at different periods during the project are included in the data. R255, 631 H981

## R73-49 DEBRIS BASIN CAPACITY NEEDS BASED ON MEASURED SEDIMENT ACCUMULATION FROM STRIP-MINED AREAS IN EASTERN KENTUCKY

Davis, J. R. and Hines, B. J. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 260-276. Accumulations in some sediment debris basins less than one year old indicated that sediment yield of 0.28 acre-feet per acre of disturbed land could be expected for a three-year design period. It was assumed, based on research experience, that

R73-49 (continued)

in three years a vegetative cover could be developed that would effectively control erosion. The engineering standard for basin construction, which was developed by the Soil Conservation Service, is appended to this paper. R654

R73-50 HIGH SURFACE TEMPERATURES ON STRIP-MINE SPOILS

Deely, D. J. and Borden, F. Y. (Penn. State Univ., School Forest Resour.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper I-6. pp 69-79. Surface temperatures of strip-mine spoil material ranging from bituminous coal to light sandstone were measured with an infrared thermometer between June 4 and July 8, 1968. The measurements indicated that heat injury to planted seedlings is a very real possibility on all commonly occurring bituminous spoil materials, especially on black bituminous coal and black organic shales. (Authors' abstract adapted) 631 H981

R73-51 APPLICATIONS OF AERIAL AND ORBITAL REMOTE SENSING TO THE STUDY OF MINED LANDS

Deely, D. J., Russell, O. R., and Wobber, F. J. (Earth Satellite Corp.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 15-25. Various kinds of remote sensing imagery have been investigated for their ability to provide information about mining operations and their usefulness in monitoring reclamation. The use of black and white low-altitude photography is well known and is often used for field reference maps and recording baseline and operating conditions. Earth Resources Technology Satellite imagery, which records in four spectral bands, distinguishes vegetation from bare land and can identify bodies of water 100 feet at the narrowest dimension. The advantage of ERTS imagery is repetitive coverage which shows continuing changes such as seasonal effects on vegetation and moisture. High altitude aircraft photography gives more detail and is more accurate than ERTS imagery. Color infrared film is considered at present to be best for the majority of uses but further investigation of multiband coverage should be made. R633

R73-52 RECLAMATION METHODS TO PREVENT WATER POLLUTION IN THE MORAVA RIVER WATERSHED

Drǎsković, D. (Chamber of Economy, Kraljevo, Yugoslavia), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VII-2. pp 361-378. Reclamation methods to prevent soil erosion are emphasized in this paper. 631 H981

R73-53 ECONOMIC IMPLICATIONS OF STRIP MINING LEGISLATION: THE SMALL FIRMS

Dreese, G. R. and Bryant, H. L., Soc. of Mining Eng. AIME Ann. Meet., Chicago, Ill., Feb. 25-March 1, 1973. Preprint No. 73-F-15. 26 pp. Costs and

R73-53 (continued)

production figures are given to show the economic impact of reclamation and pollution control legislation in Ohio on large and small mining companies. From the experience of a small, typical strip mine, the conclusion is drawn that "only the most efficient and therefore probably the largest firms will be able to remain profitable under increasingly rigid mining legislation." Confirming this, the trend toward bigger firms in the coal industry is noted. 73-26

## R73-54 APPALACHIAN COAL INDUSTRY IN 1980-HOW IT LOOKS THROUGH THE EYES OF PROFESSIONAL FORECASTERS

Dunbar, F. C., Greenwood, J. E., and Landis, R. C., Coal Age 78 (10), 90-95 (1973). This article summarizes a study made by Charles River Associates at request of the Appalachian Regional Commission. This study forecasts the outlook for the coal industry problems in 1980. It discusses the clean air, oil imports and demand for coal. Also included is a discussion on environmental control of surface mines and the supply of coal. The problem of sulfur removal from stack gases and the cost of land reclamation are treated in detail. The projection estimates reclamation and water pollution costs to be $.25 to $.50/ton which will be passed on to the utilities. (See R73-55) R230

## R73-55 THE ECONOMIC IMPACT OF PUBLIC POLICY ON THE APPALACHIAN COAL INDUSTRY AND THE REGIONAL ECONOMY

Charles River Associates, Inc. Rept. No. 173-21 - 173-23 to Appalachian Regional Comm., Jan. 1973. One of the concerns discussed is surface mining. The costs of strict environmental control and limiting output through abolition of contour mining are seen as not in the longrun limiting output or adding excessively to the price of coal. There are three volumes: I, Profile of the Appalachian Coal Industry and Its Competitive Fuels; II, Impact of Environmental and Other Policies on the Appalachian Coal Industry; and III, Appendices, which contain the data on which the first two volumes are based. 311.3 C652

## R73-56 THE MINING INDUSTRY AND FEDERAL LAND USE AND SURFACE MINING POLICY

Fannin, P. J. (U.S. Senate), Am. Mining Congr. Convention/Environ. Show, Denver, Colo., Sept. 9-12, 1973. 8 pp. The junior Senator from Arizona discusses the effects of land use legislation S268 and surface mining and reclamation act S425--both passed by the Senate and pending in the House. The Senator contends that S425 actually prevents surface mining altogether by virtue of its land classification requirements and restrictions and emphasizes that such a result would be an economic disaster for mining areas. There is now a major imbalance between environmental concern and the domestic need for energy. The Senator points out the bills are counter to the concept of private ownership of land and of state and local rights to regulate land use. 662.6 A665

R73-57 LANDSCAPE DESIGN PRINCIPLES FOR STRIP-MINE RESTORATION

Fenton, M. R., in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VII-11. pp 485-495. The development of Moraine State Park in western Pennsylvania is described. 631 H981

R73-58 THREE YEARS DEVELOPMENT OF A PUBLIC USE WILDLIFE AREA ON A MOUNTAIN COAL SURFACE MINE IN SOUTHWEST VIRGINIA

Fowler, D. K. (1) and Perry, C. H., III (2) [(1) TVA (2) Va. Comm. Game Inland Fisheries], Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 319-333. The 9,760 acre Hagy Wildlife Management Area--lying in Lee and Wise Counties, Virginia--was established in 1969, with the signing of a three year cooperative agreement between the landowner, Penn Virginia Corporation; the Virginia Division of Mined Land Reclamation; the Virginia Commission of Game and Inland Fisheries; and the Tennessee Valley Authority. The primary objective was to demonstrate that coal surface mined land lying within the 10,000 acre site could be developed as an integral productive portion of a public-use wildlife area. This paper describes the terms of the cooperative agreement, outlines the roles and responsibilities of the cooperators, and reports the results of the first three years of reclamation and the techniques used to achieve them. (From text) R659

R73-59 GROWTH AND DEVELOPMENT OF ALDER PLANTINGS ON OHIO STRIP-MINED BANKS

Funk, D. T. (North Central Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper IV-6. pp 483-491. Alnus glutinosa plantations containing several European seed sources have survived and grown well on strip-mined areas in southeastern Ohio with pH ranging from 4 to 5. After seven years, trees from southern Germany were generally larger than those from northern Germany, Belgium, Denmark, or Sweden; the tallest 20 percent of the trees in the best seed source averaged 20.4 ft in height, and 2.7 in. in diameter at breast height (d.b.h.). Multiple stems were more common in trees from provenances showing slow height growth. Trees from all seed sources in the trial grew much better on lower slopes with adequate soil moisture than on well-drained upper slopes. (From author's abstract) 631 H981

R73-60 TREE SPECIES PERFORMANCE ON KANSAS COAL SPOILS

Geyer, W. A. (Kan. State Univ.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds.,New York: Gordon and Breach, 1973. Paper V-5. pp 81-90. Preliminary analyses of 22 years of tree growth indicate several species are suitable for the reclamation of strip-mine spoils in the Kansas prairie-forest transition zone. For forest products, sycamore, eastern red cedar, bur oak, loblolly pine, and shortleaf pine were the best of the 13 species tested. Sycamore was by far the best performer.

R73-60 (continued)

Many individuals over 50 ft tall and 6 in. in diameter could be found throughout the 1947 experimental planting areas. Black locust grows well, but it spreads quickly and competes severely with other tree species. (From author's abstract) 631 H981

R73-61 CHARACTERIZATION OF COAL OVERBURDEN MATERIALS AND MINE SOILS IN ADVANCE OF SURFACE MINING

Grube, W. E., Jr., Smith, R. M., Singh, R. N., and Sobek, A. A. (W. Va. Univ.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 134-152. Chemical analyses, both in the field and in the laboratory, of sequential samples of overburden can provide information on acid-producing potential and plant nutrients available in different zones. R642

R73-62 PEDOLOGICAL INVESTIGATIONS IN THE RHINE BROWN-COAL AREA

Heide, G. (Northrhine-Westphalian State Geol. Surv., Ger.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VI-11. pp 295-313. Surveys and characterization of overburden to determine the reclamation plan are discussed. 631 H981

R73-63 A NEW METHOD OF SURFACE COAL MINING IN STEEP TERRAIN

Heine, W. N. and Guckert, W. E. (Pa. Dept. Environ. Resour.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 105-116. In the modified "block-cut method" of mining, work is planned so that overburden from the first cut is placed in a swale or gully on the hillside and, as mining progresses, overburden is deposited in previously mined sections. This method of mining is discussed in relation to the surface-mining requirements of Pennsylvania, and it is pointed out that the impact of surface mining is minimized because overburden is not pushed downslope from the mined area to become subject to erosion and landslides. R640

R73-64 THE PLANNING AND ECONOMICS OF MINED-LAND USE FOR AGRICULTURAL PURPOSES

Higgins, T. (Peabody Coal Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc. First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 287-293. The experience of Peabody Coal Company shows users that strip-mined land can be restored successfully to agricultural use. Problems with toxic soil can be reduced by mining methods, soil treatment, and choice of plants for seeding. After the reclaimed land has been revegetated, its use depends on its relation to other land in the same area. By company policy, the

R73-64 (continued)

agricultural land is organized into family farm units. Beef cow-calf operations of "live-stock share leasing" are used as an example of the costs and benefits incurred in one use of strip-mined land. Experiences with dairying and with farming of hay and row crops and cereal grain crops are also discussed. R656

R73-65 RECLAMATION AND REVEGETATION OF 640 ACRES OF SURFACE MINES--ELKINS, WEST VIRGINIA

Hill, R. D. (EPA, Robert A. Taft Water Res. Cent., Cincinnati, O.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VII-6. pp 417-450. The demonstration project was started in 1964. The control measures include air sealing an underground mine; water diversion; burying of acid-producing material; regrading and revegetation. There was some improvement in water quality. Weeping lovegrass and European alder were the species most successfully established. 631 H981

R73-66 SURFACE MINED LAND RECLAMATION RESEARCH IN EASTERN MONTANA

Hodder, R. L. (Mont. Agr. Expt. Sta.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 82-91. Rainfall in eastern Montana averages 12 inches per year. Several methods are discussed for making the most effective use of this sparse rainfall in land reclamation. Dryland planting innovations include condensation traps, supplemental root transplanting, and tubelings. Surface manipulation or configuration such as deep chiseling, gouging, or dozer basins are necessary to minimize erosion, relieve compaction, and improve the soil moisture reserve necessary to rapidly establish a desirable lasting vegetative cover. (From author's summary) R637

R73-67 WILDLIFE BENEFITS FROM STRIP-MINE RECLAMATION

Holland, F. R. (TVA, Div. Forest Develop.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper III-10. pp 377-388. In a study of four widely-separated Appalachian coal strip-mined areas reclaimed with various trees, shrubs, and grasses and compared with adjacent untreated spoils the third year after test plantings, it was found that reclamation gave significant and, most likely, long-lasting benefits. 631 H981

R73-68 THE ADMINISTRATION'S PUBLIC LANDS PROGRAM

Horton, J. O. (Assist. Sec., Land and Water Resour., U.S. Dept. Int.), Am. Mining Congr. Convention/Environ. Show, Denver, Colo. Sept. 9-12, 1973. 5 pp. The history of Federal land use policy, especially in the West, is

R73-68 (continued)

outlined as background for discussion of present land use policy. The Great Plains Resource Study is described. This comprehensive project includes the impacts from the development of coal mining in the area and will be the basis for land use decisions. 662.6 A665

## R73-69 ECONOMICS OF LAND RECLAMATION

Howland, J. W. (Pittsburg & Midway Coal Mining Co.), Green Lands 3 (2), 22 (1973). This article describes Pittsburg & Midway Coal Company's program to develop new methods and equipment to reduce the costs of dirt handling in land reclamation. Two new pieces of equipment, a 24-foot wide V blade and a 30-foot grading bar, have been built. The bar has been tested with encouraging results. R92

## R73-70 ECONOMICS OF LAND RECLAMATION

Howland, J. W. (Pittsburg & Midway Coal Mining Co.), Am. Mining Congr., Coal Convention, Report on Coal Technology, Vol. I, 1973. 5 pp. This paper describes the procedure of reclamation and particularly the test work done by the Pittsburg & Midway Coal Mining Co. on their 24' and 30' grading bar attachment. The information gives the dirt handling costs as roughly 1 cent to 1.5 cents/cu yd. Actual costs for conventional bulldozers is 4 to 6 cents/cu yd. The company goal is to reduce dirt-handling costs even further, perhaps by 50 percent. 662.6 A665

## R73-71 NEW TOOLS AND TECHNIQUES FOR RECLAIMING LAND

Howland, J. W. (The Pittsburg & Midway Coal Mining Co.), Natl. Coal Assoc./ Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 42-67. The problem of reducing the cost of earth moving was met by the development of a 40-foot, 40,000-pound angle blade. Two tractors were used in operating the big blade. Performance on both old and new spoil banks was encouraging. Design modifications necessitated by problems encountered in the field, and future testing to further improve dirt handling are discussed. Two Attachments to the paper describe necessary calculations for cost evaluations: I, "Horsepower Hours, A Proposed Guideline to Evaluate Bulldozer Performance," and II, "Volume and Work Requirements (HP HRS) Associated with Leveling Geometrically Uniform Parallel Spoil Banks (Per Acre Basis)." R635

## R73-72 INTERAGENCY EVALUATION SURFACE MINE RECLAMATION IN WEST VIRGINIA

West Virginia Dept. of Natural Resources, July 16-20, 1973. (39 pp). This report covers 4 days' observations at 13 locations in West Virginia. The group included 113 people from several agencies. Smaller groups inspected specific areas and separate comments are included by different authors on

R73-72 (continued)

their particular area. It was the general opinion that acceptable practices in all phases of strip mining are now clearly evident and definite improvement is widespread. R258

R73-73 GROWTH AND NUTRITION OF BEECH TREES ON SITES OF DIFFERENT SOIL TEXTURE IN THE LIGNITE AREA OF THE RHINELAND

Jacoby, H. (Fed. Ministry Agr. Viticulture Forests, Div. Forest Inventory, Westerwald, Ger.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper IV-1. pp 391-411. On alkaline spoil sites, beech is suitable for establishing a healthy forest. Favorable results can also be obtained with ash and maple on nutrient-rich spoil banks. With the addition of N, the spoils made up of Rhine gravel, loess and forest gravel can be rated better than the old gley forest soil. (From author's summary) 631 H981

R73-74 SURVEY OF THE STATUS OF ILLINOIS COAL SURFACE-MINED LANDS CREATED PRIOR TO JANUARY 1, 1962 (PRE-LAW)

Jewell, S. R. and Haynes, R. J. (Coop. Wildlife Res. Lab., Southern Ill. Univ.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 334-350. The Cooperative Wildlife Research Laboratory, Southern Illinois University at Carbondale, conducted in 1970 and 1971 a survey of the lands in Illinois affected by surface mining for coal prior to January 1, 1962 (Pre-law) to update existing knowledge of acreage, ownership, condition, and utilization of these lands. The total affected land encompassed 108,447 acres. The majority of the affected land is in private or coal company ownership (81,063 acres); and is in pasture, in organized recreation, and is not utilized (85,921 acres). However, only a small percentage of the land constitutes a severe pollutional problem and the reclamation of this land, although necessary, must be scientifically planned and executed to produce long-term environmental gains. (Authors' abstract corrected) R660

R73-75 RECLAMATION OF AREAS DAMAGED BY MINING ACTIVITY IN CZECHOSLOVAKIA

Jonáš, F. (Acad. Agr., Prague, Czechoslovakia), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VII-3. pp 379-394. Reclamation discussed includes earth moving, revegetation and mining planned toward reuse of the land. 631 H981

R73-76 SEED LEDGES IMPROVE STABILIZATION OF OUTER SLOPES ON MINE SPOIL

Jones, J. N., Jr., Armiger, W. H., and Hungate, G. C. (Agr. Res. Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp.

R73-76 (continued)

Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 250-258. This study, carried out over two years, demonstrates that terraces constructed on steep slopes are a definite aid in establishing vegetation to stabilize the slopes. Two mountain sites near Beckley, West Virginia were terraced and planted or seeded with combinations of birdsfoot trefoil, crownvetch and weeping lovegrass, and fertilized at various levels, and dry matter yield was measured. R653

R73-77 PALAR ... A NEW LOVEGRASS FOR THE SOUTHWEST

Joy, R. J., Slayback, R. D., and Renney, C. W. (SCS Plant Materials Cent., Tucson, Ariz.), Progr. Agr. Ariz. 24 (5), 4-5 (Sept., Oct. 1973). As a result of its performance in a nine-year evaluation program, Palar Wilman lovegrass has been released for use. It is well adapted to areas having 12 to 16 inches total annual precipitation at elevations below 4,500 feet, and moderately well adapted to drier areas where precipitation ranges from 10 to 12 inches. R434

R73-78 KENTUCKY GUIDE FOR CLASSIFICATION, USE AND VEGETATIVE TREATMENT OF SURFACE MINE SPOIL

U.S. Dept. Agr., Soil Conservation Serv., Lexington, Ky., 1971. Revised 1973. 20 pp.+ In this guide, surface mine spoil is classified and vegetation is recommended for various classifications. Also considered are plantings for differing uses of reclaimed land such as woodland, wildlife habitat, hay and pasture land. Suggestions are also made for erosion control on critical areas. R190a

R73-79 DEVELOPMENT AND APPLICATION OF THE "DOMSDORF AMELIORATIVE TREATMENT" ON TOXIC SPOIL BANKS OF LIGNITE OPENCAST MINES IN GERMANY

Knabe, W. (Northrhine-Westphalian Inst. Air Pollut. Contr. Land Use Protection, Essen, Ger.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VI-10. pp 273-294. The DOMSDORF ameliorative treatment consists of the application of hydroscopic calcareous ash from nearby power plants, fertilization, and deep soil cultivation. (From author's abstract) 631 H981

R73-80 STRIP MINING: CONFLICT OR COMPETITION

Krause, R. (Dir. Reclam. Serv., NCA), 38th North Amer. Wildlife, Natural Resour. Conf., Washington, D.C., March 20, 1973. 8 pp. Various mining methods and reclamation plans to minimize disturbance of land are described. R419

### R73-81 PREDICTING MINED-LAND SOIL

Krause, R. R. (Natl. Coal Assoc.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper I-10. pp. 121-131. The author points out that information about the physical and chemical nature of overburden materials and the influence of the weathering process is needed to predict the best handling and use of various overburden layers. 631 H981

### R73-82 UTILIZING TREATED MUNICIPAL WASTES FOR STRIP MINE RECLAMATION

Lejcher, T. R. (U.S. Forest Serv.), Mining Eng. 25 (3), 49-50 (1973). This article describes the cooperative work of the U.S. Forest Service with the Metropolitan Sanitary District of Greater Chicago. This project combined acid spoil with anaerobically digested sewage sludge on 77 hectares of strip-mined land south of Chicago where drainage from acid spoil caused severe pollution. Experimental plots were treated with sludge and seeded with weeping lovegrass. Several levels of application of sludge were used. The most successful was the heaviest application, 303.7 dry mt per hectare. R422

### R73-83 NEW SURFACE MINING TECHNOLOGY TO MINIMIZE ENVIRONMENTAL DISTURBANCE

Lusk, B. E. and Mulhern, J. J., Am. Mining Congr. Mining Conv. Environ. Show, Denver, Colo., Sept. 9-12, 1973. 15 pp. A grant was awarded to West Virginia Surface Mining and Reclamation Association by Environmental Protection Agency to study longwall stripping. This practice uses longwall mining under relatively shallow cover to achieve total resource recovery and minimize mine drainage and other environmental problems. A number of diagrams illustrate how the stripping is done. R626

### R73-84 PREVENTING THE SEDIMENTATION OF STREAMS IN A PACIFIC NORTHWEST COAL SURFACE MINE

McCarthy, R. E. (Washington Irrigation & Development Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 277-286. Water pollution control needed in developing a strip mine near Centralia, Washington was prevention of sediment in the discharge into Hanaford Creek, the receiving stream. Acid-forming materials were not present. Since the claylike soil tended to remain in suspension, polyelectrolyte flocculant treatment was used in addition to settling ponds. The process was designed to handle the extended periods of high runoff and occasional peak flows common to the area. It has also been automated to continually monitor the water flow and to add the correct amount of flocculant into the turbid water. Water analysis three times a day above and below the mine, assures that the overflow from the final settling pond does not carry siltation. R655

## R73-85 SURFACE MINE SILTATION CONTROL

McCarthy, R. E., Am. Mining Congr., Coal Convention, Report on Coal Technology, Vol. II, 1973. 9 pp. The system of clarifying turbid water from the mining operation is described. Suspended sediment is flocculated with a polyelectrolyte. The suspension settles out in ponds and clear water overflows into the receiving stream. 662.6 A665

## R73-86 PERCOLATE FROM SPOILS TREATED WITH SEWAGE EFFLUENT AND SLUDGE

McCormick, L. H. and Borden, F. Y. (Penn. State Univ., School Forest Resour.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper II-7. pp 239-250. Analyses showed that the pH of percolate experienced an increase which was related to both the amount and method of application of sludge. The initial increase in the Ca and K concentration in the percolate followed by a gradual decline suggested a partial saturation of the exchange sites of the colloidal portion of the spoils by ammonia. Although initially high, the S concentrations of the percolates resulting from the sludge treatments eventually fell below those of the control treatment which was only demineralized water. In general, the spoils provided satisfactory renovation of the major chemical constituents of sludge and effluent. 631 H981

## R73-87 STATEMENT - HEARINGS ON SURFACE MINING LEGISLATION

MacGregor, I. (American Metal Climax, Inc.), U.S. House of Representatives, Committee on Interior and Insular Affairs, May 14, 1973. 13 pp.+ This statement deals with the economics of the mining industry and projects the effects of restrictive measures on the industry's ability to supply energy and other minerals and metals. R503

## R73-88 USING WASTEWATER SOLIDS TO RECLAIM STRIP-MINED LAND

McMillan, H. and Carlson, R., AIME Ann. Meet., Chicago, Ill., Feb. 25-Mar. 1, 1973. Preprint No. 73-F-66. 25 pp. This paper describes the operation of the Metropolitan Sanitary District of Greater Chicago. The wastes from a population of 4-1/2 million people are collected and treated to give 1300 million gallons of waste water and 700 dry tons of solids. The solids were used to reclaim strip-mined lands. A corn crop was first grown giving 60 bushels/acre. The paper contains many other examples in other areas where the waste water and solids were used as fertilizer treatments to produce significant results. This program was called "Solids on Land"--a program which produces organic nutrients and liquid fertilizer to help revegetate disturbed lands from coal and sand operations. R276

R73-89 SELECTING PLANT SPECIES FOR REVEGETATING SURFACE COAL MINED LANDS IN INDIANA - A FORTY-YEAR RECORD

Medvick, C. (Mid-West Coal Producers Inst., Terre Haute, Ind.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper V-4. pp 65-80. The chronological trend in the use of 16 conifer and 28 broadleaf tree species is described. Discontinued species and species currently in use are indicated. Use of perennial plants other than trees is also discussed and those grass and legume species found to produce satisfactory forage stands are indicated. Categories of overburden materials encountered in Indiana and the recommended revegetation are also described. (From author's abstract) 631 H981

R73-90 PERFORMANCE OF PLANTS IN RELATION TO SPOIL CLASSIFICATION IN PENNSYLVANIA

Miles, V. C., Ruble, R. W., and Bond, R. L. (Soil Conservation Serv., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper V-2. pp 13-31. The use of the spoil classification which is based mainly on pH, slope, and stoniness is demonstrated, also the performance of the major grass, legume, shrub and tree species used in Pennsylvania is summarized. 631 H981

R73-91 MINING INDUSTRY FACES TOTAL SHUTDOWN UNDER S-425

Mining Congr. J. 59 (4), 105-136 (1973). This article contains statements at the Senate hearings, March 14, 1973 of seven executives representing different areas of mining. Pages 118-124 carry the statement of E. R. Phelps of Peabody Coal Co. describing reclamation procedures in the coal mining industry. Mr. Phelps discusses factors involved in both deep and surface mining. He explains in detail the problems and procedures of the surface mining industry. Mr. Phelps cites the program and progress of his own company and the number of acres of stripped land reclaimed in one year. R114

R73-92 LAND USE PLANNING OF SURFACE-MINED LAND

Montgomery, H. B., Symp. Surface Mine Reclamation and Land Use Reclamation, Lees College, Jackson, Ky., by Scientists and Engineers for Appalachia, Oct. 1973. 15 pp.+ This paper describes policy needed to make best use of areas affected by surface mining. Considerable discussion covers all phases of such a land use program and it outlines the following conclusions which must be attained so that such a program can be successful: "(1) all requirements of the law must be provided for; (2) the design mining and use developopment process set forth are compatible with reasonable expectations that cooperation and where necessary enforcement will be effective in preserving the integrity of the project and environmental impact design, and finally (3) the public should be fully informed and drawn into the process program for they are the community of interest that will live with the project benefits and sorrows." R263

R73-93 STATEMENT BEFORE U.S. HOUSE OF REPRESENTATIVES, COMMITTEE ON INTERIOR AND INSULAR AFFAIRS, MAY 14, 1973

Morton, P. (Cannelton Industries, Inc.), Green Lands 3 (2), 34-35, 37 (1973). The statement criticizes proposed legislative requirements to eliminate highwalls from strip mining and to prevent mining on steep slopes. Four mining methods which will prevent or reduce landslides and erosion from mining in mountainous areas are discussed. They are slope reduction, box cut, valley fill, and area mining of mountain tops. R96

R73-94 WVSMRA RECEIVES FEDERAL GRANT. NEW SURFACE MINING TECHNOLOGY TO MINIMIZE ENVIRONMENTAL DISTURBANCES

Mulhern, J. J. (1) and Lusk, B. E. (2) [(1) EPA and (2) W. Va. Surface Min. Rec. Assoc.], Green Lands 3 (3), 16-18 (1973). Longwall mining as it might be applied to shallow seams is described. The grant will support a demonstration project which will show the feasibility of the method. It is expected that the method will give total resource recovery with minimum disturbance of vegetation and reduction of the problem of acid drainage. R235

R73-95 THE MICROFLORA OF DUMPED SOILS IN TWO OPEN CAST BROWN-COAL MINING REGIONS OF POLAND

Müller, K. (Polish Acad. Sci.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper III-5. pp 325-334. The studies in 1966 and 1967 showed that where soils are predominately basic, microbiological activity is dependent on plant life, either volunteer or planned, on the site. With acid soils, the chemical composition of the soils affects the amounts and groups of microorganisms present. 631 H981

R73-96 SMALL MAMMALS ON SURFACE-MINED LAND IN SOUTHWESTERN INDIANA

Mumford, R. E. and Bramble, W. C. (Purdue Univ., Dept. Forestry and Conservation), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper III-9. pp 369-376. Mice were found to be abundant and to be a significant part of the wildlife food chain found on surface-mined lands studied. 631 H981

R73-97 STRIP MINING - AN ANNOTATED BIBLIOGRAPHY

Munn, R. F., Morgantown: W. Va. Univ. Library, 1973. 110 pp. The 611 citations are separated into several categories including History, Government Regulation, The Controversy Over Stripping, Environmental Effects, and Reclamation. The index covers both authors and subjects. 631 M966

R73-98 SUCCESSION OF SOIL FAUNA IN AFFORESTED SPOIL BANKS OF THE BROWN-COAL MINING DISTRICT OF COLOGNE

Neumann, U. (Univ. Cologne, Zool. Inst.), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper III-6. pp 335-348. Fauna, as well as bacteria, break down plant and leaf litter to form good soil. Three different fauna were investigated in this study. Results show that development of fauna on spoil was dependent on a cool moist micro climate, especially digestible leaf litter, soil moisture, and availability of species by migration or by other means of introduction. 631 H981

R73-99 NEW USES FOR FLY ASH AND MINE WASTE - FLY ASH USED IN SPECIAL RECLAMATION PROJECT

Green Lands 3 (3), 20 (1973). A project to reclaim abandoned strip-mine lands in Marion County, West Virginia is described. Half of the area is being treated with 200 tons per acre fly ash and the other half is being used as a control plot. The total area was backfilled and regraded, fertilized and seeded. The control area also was treated with six tons of lime per acre. R236

R73-100 LANDSCAPE PLANNING ON AN ECOLOGICAL BASIS

Olschowy, G. (Fed. Inst. Vegetational Res., Nature Conserv., Landscape Management Bonn-Bad, Ger.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VII-10. pp 477-484. Since large-scale mining in Germany does not avoid anything in its path, reclamation includes complete relocation of housing, farms, roads, and waterways. The planning for this restoration is described. 631 H981

R73-101 OUTDOOR RECREATION ACTION

Bur. Outdoor Recreation, U.S. Dept. Int., Rept. No. 28 (1973). 48 pp. This booklet contains proceedings of the First National Conference on Reclamation of Surface-Mined Lands for Outdoor Recreation held in Washington, D.C., May 14 and 15, 1973. Also included is information on federal and state organizations and administration and on federal, state and local financing of outdoor recreation. R351

R73-102 PLANNING APPROACHES TO SURFACE MINING ON THE NATIONAL FORESTS

Paller, W. and Schultz, D. A. (Caribou Natl. Forest), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 68-81. Phosphate mining in Caribou National Forest, Pocatello, Idaho, is discussed and related to the general problems of strip mining. An administrative study by the Forest Service and

R73-102 (continued)

four members of the Phosphate Mining Industry considered reclamation of areas already mined and made plans for future mining to minimize effects of disturbing land. Surface mining is also considered in relation to multiple use of an area with nonrenewable resources and to its impact on such factors as timber production, wildlife needs, water quality, fisheries, and groundwater supplies. R636

## R73-103 PEABODY'S UNIVERSAL MINE: A SHOWPLACE

Coal Mining Process. 10 (11), 40-41 (1973). This Universal Mine of Peabody Coal Co. near Terre Haute, Indiana, is an example of efficiency. Processing rate is 800-900 tph and reclamation is carried out simultaneously using the mining equipment. All topsoil is saved to cover the spoil material. An average grade of 8 percent is the finished surface area which they intend to use for cropland. Their system of handling material is producing a high operating availability - sometimes up to 83 percent. R233

## R73-104 AMELIORATION OF COAL MINE SPOILS WITH DIGESTED SEWAGE SLUDGE

Peterson, J. R. and Gschwind, J. (Metropolitan San. Dist. Greater Chicago), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 187-196. Test plots on a barren acidic coal-mine spoil in southern Illinois showed that application of 200-250 dry tons/acre (448-560 dry metric tons/ha) would result in a permanent vigorous grass cover while subsurface water quality was upgraded. Improvements in leachate water quality and in the spoil material itself were confirmed by laboratory column studies in which sludge treated and untreated acidic spoil material was leached daily for 110 days. Berm structures direct all field runoff to retention basins so that water quality may be checked before discharge to lakes and streams. Other environmental safeguards include nutrient barriers of shrubs and grasses along lakes and streams and monitoring wells. These are sampled periodically to insure no pollution of local water resources. (From authors' summary) R646

## R73-105 STATEMENT - HEARINGS ON SURFACE MINING LEGISLATION

Phelps, E. R. (Peabody Coal Co.), U.S. House of Representatives, Committee on Interior and Insular Affairs, May 14, 1973. 25 pp. The testimony emphasizes that general standards and goals of reclamation should be required by law instead of specific methods of achieving specific results. Implications of some of the language of the bill and the economic impact of some provisions are discussed. R504

R73-106 BOLT MOUNTAIN DEMONSTRATION OF MULCHES AND SOIL STABILIZERS - SIXTEEN WEEK PROGRESS REPORT

Plass, W. T., Green Lands 3 (1), 14-15 (1973). This article describes the continuation of revegetation work conducted on Bolt Mountain using a series of mulches and stabilizers for rapid germination. Erosion control was also a prime objective of the work. A large number of materials were used on this project and detailed results are given for each application. Ranger Fuel Corporation did most of the planting using a hydroseeder. R122

R73-107 GENETIC VARIABILITY IN SURVIVAL AND GROWTH OF VIRGINIA PINE PLANTED ON ACID SURFACE-MINE SPOIL

Plass, W. T. (Northeastern Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper IV-7. pp 493-507. Fifty-seven open-pollinated Virginia pine progeny from 10 natural stands scattered through Tennessee and Kentucky were evaluated under field and greenhouse conditions to determine if genetic variability would influence survival and growth on extremely acid spoil. Significant differences between progeny indicate that, through selection and breeding programs, there may be a possibility of developing improved planting stock for strongly acid surface-mine spoil. (From author's abstract and introduction) 631 H981

R73-108 REVEGETATING SURFACE MINED LAND

Plass, W. T. (Forest Serv., U.S. Dept. Agr.), Green Lands 3 (2), 26-28 (1973). Chemical and physical characteristics of the overburden affect successful reclamation. The author gives practical examples of plant germination and growth on different types of overburden, and on spoils with varying treatments. There is a continuing search for plant materials adapted to acid spoils. R93

R73-109 REVEGETATING SURFACE MINED LAND

Plass, W. T. (Forest Serv., U.S. Dept. Agr.), Coal Mining Process. 10 (7), 54-55 (1973). Several Appalachian revegetation projects are discussed and illustrated. R89

R73-110 REVEGETATING SURFACE MINED LAND

Plass, W. T., Am. Mining Congr., Coal Convention, Report on Coal Technology, Vol. II, 1973. 25 pp. This paper discusses the three major topics in reclamation - site evalaution, site preparation, and revegetation techniques. Plant material and soil testing are noted as subjects for continuing investigation. The author indicates trends in the future will be toward more intensive land management. 662.6 A665

R73-111 CHEMICAL PROPERTIES AND PARTICLE-SIZE DISTRIBUTION OF 39 SURFACE-MINE SPOILS IN SOUTHERN WEST VIRGINIA

Plass, W. T. and Vogel, W. G., Northeastern Forest Expt. Sta., U.S. Dept. Agr., Forest Serv. Res. Paper NE-276 (1973). 8 pp. A survey of 39 surface-mine sites in southern West Virginia showed that most of the spoils from current mining operations had a pH of 5.0 or higher. Soil-size material averaged 37 percent of the weight of the spoils sampled. A major problem for the establishment of vegetation was a deficiency of nitrogen and phosphorus. This can be corrected with additions of fertilizer at appropriate rates. (Authors' abstract) R598

R73-112 PROCEEDINGS DIGEST: MID-ATLANTIC REGIONAL CONF. ON SURFACE MINED LAND FOR OUTDOOR RECREATION

University Park, Pa., by Bur. Outdoor Recreation, Bur. Mines, Pa. State Univ., Dec. 12-14, 1973. 57 pp.+ Representatives of federal and state government units, universities, and the coal industry discussed the extent of strip mining in the area, recreation needs and factors to be considered in developing recreation areas from strip-mined lands. R420

R73-113 PROCEEDINGS, REGIONAL CONFERENCE ON RECLAMATION OF SURFACE-MINED LAND FOR OUTDOOR RECREATION

Bur. Mines and Bur. Outdoor Rec., U.S. Dept. Int., Kent State Univ., May 22, 23, 1973. 124 pp. The two-day session contained many papers covering all phases of reclamation with emphasis on land use for recreational purposes. R337

R73-114 PROCESSES, PROCEDURES, AND METHODS TO CONTROL POLLUTION FROM MINING ACTIVITIES

Skelly and Loy, Rept. to U.S. EPA, Washington, D.C., EPA-430/9-73-011, (Oct. 1973). 390 pp. Methods for controlling and abating water pollution from both deep and surface mining are described. R341

R73-115 PROPOSED PLAN OF MINING AND RECLAMATION BIG SKY MINE, PEABODY COAL COMPANY, COAL LEASE M-15965, COLSTRIP, MONTANA

Geol. Surv., U.S. Dept. Int., DES 73-64, Oct. 25, 1973. This is the draft environmental statement for developing the operating mine into coal deposits leased from the Federal Government. 631 U34

R73-116 HYBRID POPLARS ON SPOIL BANKS

Reber, N. F., Pa. Farmer, Feb. 9, 1973. The rapid growth of hybrid poplars on strip-mined land in central Pennsylvania has led to the suggestion of using it

R73-116 (continued)

for pulpwood. R455

## R73-117 RECLAMATION PROGRAMS KEEP W. VA. GREEN

Norfolk and Western Magazine 51 (10), 2-3 (1973). This article describes the efforts of the Pocahontas Land Corporation which oversees some 580,000 acres of railway-owned land in the state. This company plants about 25,000 trees a year and now has a fund of information on what trees grow best in certain reclaimed areas. The company finds a general lack of knowledge or acquaintance on the part of the public about strip-mine reclamation. They feel this attitude could be changed if people would go and see for themselves. The media has painted a dark picture from years ago and this image is still re-echoed today. The new-box cut,backhauling method adds real value to the stripped land,a figure in excess of the original value. R328

## R73-118 RECLAMATION: RESTORING BEAUTY AND BALANCE IS US STEEL'S GOAL

Coal Age 78 (11), 100-104 (1973). This article illustrates US Steel's reclamation and mine drainage efforts. They use broadcasting, hydroseeding, aerial seeding, and seedling planting depending on the area to be reclaimed. The company has reclaimed 17,000 acres in Kentucky, West Virginia, Pennsylvania, and Alabama, and 9,000 acres in the Gary, West Virginia rea. Although a lime storage tank has been built before the aerator at the Maple Creek water treatment plant, the water presently is alkaline so that only aeration and settling are required. The water from the Robena complex ranges from mildly alkaline to highly acid, and the treatment includes lime neutralization plus aeration and settling. R221

## R73-119 RECLAMATION OF TOXIC SPOIL STACK FOR VARIOUS SELECTED SOIL CONDITIONS - WITH THE TUROW LIGNITE MINE AS EXAMPLE

Poltegor, Main Res. Design Inst. Opencast Mining, Wrocław, Poland, 1st. Interim Rept. to U.S. EPA, Spec. Foreign Currency Program Proj. No. 05-532-11, Nov. 1973. 58 pp. This report is the first in a 3-year program conducted at the Turow Mine in Poland to develop a reclamation process for the toxic overburden. There are tabulated data for weather, water conditions and analysis, snowfall, wind, and physical and chemical characteristics of overburden including trace elements. Both volunteer and experimental species growing on the reclaimed land are listed. Photographic records of vegetation were not clear in the copy available to be abstracted. Several neutralizing agents were used in various combinations on the acid soil. R446

## R73-120 STRIP MINE RECLAMATION - CHALLENGES, PLANNING AND CONCEPTS

Reiss, I. H., Mining Congr. J. 59 (4), 41-45 (1973). The reclamation program of Meadowlark Farms, Inc., a subsidiary of Amax Coal Co., is described and

R73-120 (continued)

shown in several pictures. Farm-land development, tree planting, and beef production are being carried out. R113

## R73-121 RESTORING SURFACE-MINED LAND

U.S. Dept. Agr., Misc. Publ. No. 1082, 1968. 18 pp. Revised 1973. 14 pp. Statistics on disturbed areas and surface mining sites as of Jan. 1, 1965. have been compiled for all 50 states. A tabulation of requirements for licenses or permits, bonding, reclamation, refuse handling, and substitution of sites is given for eleven eastern mining states. The June 1973 revision still carries the same publication number. Several of the charts have been updated, and information on state reclamation laws has been omitted. R205a

## R73-122 CHEMICAL ALTERATIONS OF STRIP-MINE SPOIL BY FURROW GRADING--REVEGETATION SUCCESS

Riley, C. V. (Kent State Univ.), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VI-12. pp 315-331. A 7-year comparative study (1962-1968) of furrow-graded versus conventional smooth-graded spoils showed that the modified furrow grading technique resulted in a very marked site improvement and greatly enhanced reclamation. 631 H981

## R73-123 DESIGN CRITERIA OF MINED LAND RECLAMATION

Riley, C. V. (Kent State Univ.), Mining Eng. 25 (3), 41-44 (1973). Criteria essential to insuring successful mined-land reclamation must include a knowledge and appreciation of the significance of the geochemistry of the overburden, spoil placement grading for proper topography and spoil surface, all relative to improved site conditions necessary for the successful establishment of vegetation, spoil stabilization, erosion control and water management. (From Text) R421

## R73-124 FURROW GRADING - KEY TO SUCCESSFUL RECLAMATION

Riley, C. V. (Kent State Univ.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 159-177. This study, carried out from 1963 to 1972, was designed to evaluate the effectiveness of a rough or furrowed spoil surface and a relatively flat topography on improving the mined land's ability to support vegetation. This type of earth preparation was compared with the conventional smooth spoil surface. Ridges bulldozed into the furrowed surface were 24 to 36 inches in height and 36 to 48 inches between peaks. The ridges were filled in naturally over the time of the study until they were from 2 to 6 inches high. Initial spoil analyses revealed extremely high levels of soluble salts, sulphates, metal ions, and pH range of 3.1 to 4.1. Data from a program of

R73-124 (continued)

soil sampling of ridges and ravines showed decreasing acidity and significantly lower levels of soluble salts in ravine sites than on ridges or conventionally smooth surfaces. Furrowing the mining site created a surface conducive to rainfall retention, absorption, and infiltration, and resulted in increased leaching of soluble salts, sulphates, and other chemicals harmful to plants. Site improvement was reflected by better plant survival, growth, and reproduction in the ravine than on the ridges or on the smooth surface. R644

### R73-125 ROTARY DRILLS HANDLE PROSPECTING TOO

Coal Mining Process. 10 (6), 45-47 (1973). The prospecting and mining methods of the Hallmark and Reid Coal Co. in their strip-mining operation in Alabama are described as well as their progress in reclamation. R42

### R73-126 NODULATION BY VARIOUS STRAINS OF RHIZOBIUM WITH ROBINA PSEUDOACACIA SEEDLINGS PLANTED IN STRIP-MINE SPOIL

Rothwell, F. M. (Ind. State Univ., Terre Haute), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper III-7. pp 349-355. Sixteen strains of Rhizobium were investigated to determine their ability to nodulate with Robina pseudoacacia L. seedlings which were grown in four eastern Kentucky strip-mine spoils. Three of the bacterial strains were effective in all spoil types and two strains nodulated in three of the four spoil types when the seedlings were grown under controlled conditions. (From author's abstract) 631 H981

### R73-127 PROJECTING THE USE OF NEW PLANT MATERIALS FOR SPECIAL RECLAMATION PROBLEMS

Ruffner, J. D. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 233-242. Successful vegetation of spoil banks requires knowledge both of the site and of the plants to be used. The Soil Conservation Service has developed vegetative-species guides based on mine-spoil classification. The guide developed for strip-mined lands in Kentucky is used as an example. Spoil is classified by soil reaction (acidity or alkalinity), degree of slope, texture, and stoniness. Species of grasses, legumes, shrubs or ground cover, and trees are listed according to conditions for which they are suitable. New plant material is evaluated under a variety of conditions to determine its range of adaptability. Proper management of revegetation of strip-mined land can be planned by use of a vegetative guide along with consideration of other factors affecting growth, such as exposure, spoil compaction, amount of precipitation, and special requirements of species, such as the need for a particular nutrient or temporary cover because of slow germination. R651

R73-128 EVALUATION OF PLANTS FOR USE ON CRITICAL SITES

Ruffner, J. D. and Steiner, W. W. (Soil Conservation Serv., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper V-1. pp 3-12. A number of plants found suitable for establishment on surface-mined lands and techniques for accomplishing this are discussed. 631 H981

R73-129 LIGNITE MINE SPOILS IN THE NORTHERN GREAT PLAINS--CHARACTERISTICS AND POTENTIAL FOR RECLAMATION

Sandoval, F. M., Bond, J. J., Power, J. F., and Willis, W. O. (Northern Great Plains Res. Cent., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 117-133. Spoils from strip mining for lignite and subbituminous coal in North Dakota, Montana, and Wyoming were studied in the laboratory and in the field to evaluate their potential for reclamation and revegetation. Results show that the physiochemical properties of the materials provide a very poor environment for vegetative growth. Materials from the Tongue River and Sentinel Butte Formations within the Fort Union group were often extremely fine-textured, moderately saline, and highly sodic. Severity of the problems associated with high clay and high adsorbed-sodium contentincreases with depth from the original surface. Low organic matter combined with fine texture enhances the sodium-dispersion effect which renders the spoil materials extremely unstable, highly impermeable, and erodible to water. Available phosphorus in spoil materials was very low. Available nitrogen depended on the age of the exposed spoils. Treatments showing promise for reclamation include fertilization (especially phosphorus) in combination with the use of topsoil, vegetative (straw) mulches, and possibly gypsum as a calcium amendment, although response to gypsum in field studies has been disappointingly slow. (Authors' abstract adapted) R641

R73-130 THE BLOCK METHOD OF STRIP MINING

Saperstein, L. W. and Secor, E. S. (Pa. State Univ., Dept. Miner. Eng.), AIME Ann. Meet., Chicago, Ill., 1973. 73-F-51. 27 pp. This paper supports the practice of block strip-mining for its advantages in reclamation and its ability to reduce the severity of mine drainage. The authors explain that the block method can use equipment familiar to most operators and is generally more flexible than other types of mining. A series of diagrams appears at the end of this article showing how the block method works and explaining the actual movement of material. AIME

R73-131 IMPROVED RECLAMATION POTENTIAL WITH THE BLOCK METHOD OF CONTOUR STRIPPING

Saperstein, L. W. and Secor, E. S. (The Pa. State Univ.) Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 1-14. The block method of mining

R73-131 (continued)

which has been used successfully in strip mining on hillsides is described in detail. Mining is carried out in sections so that overburden from an area being mined can be placed in a mined-out area as mining proceeds. Overburden handling can be planned so that acid-producing soil can be segregated and buried and topsoil can be reserved for final spreading. A cursory investigation of the economics of the block method indicates that it is no more expensive and may cost less than conventional dragline pull-back mining. R632

## R73-132 EVALUATION OF MUNICIPAL COMPOST FOR STRIP MINE RECLAMATION

Scanlon, D. H., Duggan, C., and Bean, S. D., Reprinted from Compost Sci. 14 (3) (1973). 5 pp. The purpose of this work was to test the effects of both heavy and light compost on coal strip-mine sites. The trial plots were located on a mountain strip mine at 2000-foot elevation in Wise County, Virginia. The test area supported no vegetation and had a pH range of 2.8 to 4.7 with an average of 3.6. Various amounts of compost raised the pH values of the spoil material to levels which supported good growths of Virginia pine. Research showed that compost applied as low as 14 tons/acre will increase vegetation on mine spoils. R201

## R73-133 SOME EXPERIENCES WITH VARIOUS SPECIES IN DANISH RECLAMATION WORK

Schlätzer, G. (Ministry Agr. Planting Cent., Kibaek, Denmark), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper V-3. pp 33-64. The paper describes the harsh conditions of this arboretum and another strip-mined area (poor acid sands, high winds, and late frost) and the simple planting techniques used; relates some experiences in amelioration, and gives some examples of the species present; it then presents some experiences with species in reclamation work. Based on these experiences, the suitability of some species for wider use is also discussed. (From author's abstract) 631 H981

## R73-134 SEEDING AND MULCHING--MODERN METHODS AND EQUIPMENT

Schulze, W. L. (Finn Equipment Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation, Pittsburgh, Pa. (1973). 2 pp. Hydroseeding and mechanical applications of mulch are discussed briefly. R661

## R73-135 SELECTED PAPERS AND REMARKS FROM THE RESEARCH AND APPLIED TECHNOLOGY SYMPOSIUM ON MINED-LAND RECLAMATION

National Coal Association, 1973. 150 pp. This is a selection of twelve papers from the thirty given at the Mined-Land Symposium in Pittsburgh, March 1973. The publication notes that all thirty papers are available at the BCR laboratory in Monroeville, Pa. R330

## R73-136 SURFACE MINED LAND RECLAMATION RESEARCH AT COLSTRIP, MONTANA

Sindelar, B. W., Atkinson, R., Majerus, M., and Proctor, K. (Montana State Univ., Dept. Animal Range Sci.), Montana Agr. Expt. Sta. Res. Rept. 69 (Progr. Rept. 1973-1974). 98 pp. Montana law requires reclamation to provide "suitable permanent diverse vegetative cover" and allows no more soil erosion than would have occurred before mining. Precipitation in the area averages 15 inches/year and weather conditions vary widely and can be severe. Studies to aid in developing successful reclamation methods under these conditions include methods of soil manipulation to improve water retention; evaluation of establishment of trees, grasses, shrubs, and legumes over several growing seasons; topsoil depth and gradient studies; comparison of fertilized mined lands with fertilized native range; and a rodent population survey on areas used in vegetative studies. R589

## R73-137 STATEMENT ON SURFACE MINING PROPOSALS BEFORE THE ENVIRONMENT AND MINES AND MINING SUBCOMMITTEES OF THE HOUSE OF REPRESENTATIVES COMMITTEE ON INTERIOR AND INSULAR AFFAIRS, APRIL 9, 1973

Slack, J. (U.S. House of Representatives), Green Lands 3 (2), 38-39 (1973). Congressman Slack urges that legislation be written to "place environmental safeguards around a method of extraction." He also points out that a compensation clause is needed since, at least in West Virginia, coal reserves are assessed and taxed as private property. R97

## R73-138 CHOOSING TOPSOIL TO FIT THE NEEDS

Smith, R. M. (W. Va. Univ.), Green Lands 3 (2), 30-31 (1973). The author defines the meaning of the word "topsoil" and its purpose in reclamation. Originally the connotation presumed fertile soil material. "Topsoiling" is now recommended widely for mined land and other drastically disturbed land areas, but it is also practiced for the improvement of many natural soils as well. There are three kinds of topsoil: synthetic topsoil, weathered topsoil, and geologic topsoil. Description of each of the three types of topsoil, their advantages, and a discussion of their use is included. Jour

## R73-139 STATE-BY-STATE REPORTS ON COAL WEST OF MISSISSIPPI INCLUDING CANADA

Coal Age 78 (5), 75-236 (1973). This article outlines by states the coal deposits and related subjects, including reclamation, for the states west of the Mississippi. R267

## R73-140 STEEP SLOPE MINING . . . A NEW CONCEPT

Green Lands 3 (2), 4-6 (1973). This method of surface mining is applied on 65 percent slopes and above. The outer spoil bank and highwall are almost totally eliminated. Several advantages are 25 to 35 percent reduction in affected acreage, elimination of slides, reduced drainage system, and number of

R73-140 (continued)

silt ponds. Controlled blasting allows 100 percent of overburden to be kept on the bench. Revegetation and reclamation costs have been reduced since material is handled only once instead of the conventional two or three times. Jour

### R73-141 AN ANALYSIS OF STRIP MINING METHODS AND EQUIPMENT SELECTION

Stefanko, R., Ramani, R. V., and Ferko, M. R., Penn. State Univ., Interim Rept. No. 7 to U.S. Office Coal Res., R&D Rept. 61 (1973). 134 pp. This report reviews all methods and equipment used for strip mining. Although considerable emphasis is placed on specific items of mining equipment, there is also particular reference to reclamation and proper methods of waste disposal. Many sketches and diagrams show the ways to handle overburden and proper methods of building spoil areas. Diagrams also show how to handle the water problem and how to locate artificial lakes. R240

### R73-142 COAL IS CHEAP, HATED, ABUNDANT, FILTHY, NEEDED

Stein, J., Smithsonian 3 (11), 18-27 (1973). This article treats the whole situation of coal mining, burning, and gasifying and includes pictures and discussion of the problems of stack-gas emission, mine-acid production, waste disposal and land reclamation. Pictures show the result of unreclaimed strip-mine areas as well as those which were graded and planted. Costs of 10 to 50 cents/ton for reclamation are reported. A section discusses both state and federal strip-mine laws. R497

### R73-143 SURFACE MINING DISTURBANCE AND WATER QUALITY IN EASTERN KENTUCKY

Striffler, W. D. (Northeastern Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 1, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper II-4. pp 175-191. A survey of water quality was conducted in eastern Kentucky during the summer of 1966. A total of 180 sampling points, including all fourth-order and larger watersheds, were measured. Field measurements included stream discharge, water temperature, dissolved oxygen, pH, oxidation-reduction potential and specific conductance. Laboratory determinations included Al, Ca, Mg, total Fe, Mn, and sulfates. In summary, although acid pollution is a very serious problem on small, severely disturbed watersheds, it is not important on the larger watersheds or major rivers during low-flow conditions in eastern Kentucky. (From author's abstract) 631 H981

### R73-144 SURFACE MINING COAL VIA LONGWALL METHOD

Coal Mining Process. 10 (10), 60-61 (1973). This article describes a new longwall mining method for removing shallow seams. The method uses a longwall shearer and roof support chocks. This method causes minimal environmental disturbance, reduces mine drainage, and the only restoration needed will

R73-144 (continued)

be on the edge of the 4- to 6-ft coal seam. A diagram is supplied to show the proposed general arrangement which is expected to prove that surface coal mining can be balanced with a clean environment. R216

### R73-145 SURFACE MINING IN WEST VIRGINIA: THE STANFORD REPORT IN PERSPECTIVE

Mid-Appalachian Environ. Serv., Jan. 1973. 29 pp. A series of papers given at a symposium in Charleston, West Virginia Civic Center, February 26, 1972, includes comments on each of the following categories: reclamation and environment; the law and its enforcement; psychological and social effects; and energy and economics. The Stanford Report on strip mining was prepared for the West Virginia Legislature's Committee on Government and Finance. R251

### R73-146 ESTABLISHMENT OF VEGETATION ON TOXIC COAL MINE SPOILS

Sutton, P. (Ohio Agr. Res. Develop. Cent.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 153-158. These studies to find methods to establish vegetation on toxic spoil were carried out in Noble County, Ohio. The results indicate that vegetation can be established by covering toxic spoils with suitable material, by use of limestone to neutralize acidity, by the addition of organic materials such as sewage sludge or manure, and by suitable plant species. However, root systems are confined to non-toxic or treated layers. R643

### R73-147 RECLAMATION OF TOXIC STRIPMINE SPOILBANKS

Sutton, P., Ohio Report, Ohio Agr. Res. Develop. Cent., 58 (1), 18-20 (Jan-Feb 1973). A demonstration project on two spoil banks at the Eastern Ohio Resource Development Center was carried out cooperatively with the Bureau of Mines. One area had more shale and clay in the spoil; the other had more sandstone. Toxic materials were buried during grading. Fertilizer and limestone treatments were applied to selected areas. Tree survival overall was not more than 25 percent. Water samples were taken at four different drainage areas before and after reclamation. One area was covered with 18 inches of non-toxic spoil and this produced a good cover of sweet clover and lespedeza. Final evaluation will have to await results over several years, particularly tree growth in the non-toxic spoil area. R518

### R73-148 TREAT STRIPMINE SPOILS WITH SEWAGE SLUDGE

Sutton, P. and Vimmerstedt, J. P. (Ohio Agr. R&D Cent.), Ohio Rept., Nov-Dec 1973. pp 121-123. In a cooperative project between the city of Caldwell, Ohio and the Eastern Ohio Resource Development Center, sewage sludge was applied to strip-mine-spoil areas. In one case a heavy growth of rye was produced. An adjacent plot with limestone and fertilizer produced no rye.

R73-148 (continued)

Several similar comparisons are included indicating that sewage sludge is an effective fertilizer. R345

R73-149 TWO ENVIRONMENTAL ANALYSES INVOLVING AGRICULTURE

Swanson, E. R. (Univ. Ill.), 7th Ann. Symp. Interface, Workshop on Decision & Environmental Analyses held in connection with Computer Sci. & Statistics, Ames, Iowa, October 1973. (8 pp). The second part of the paper discusses the project of the Metropolitan Sanitary District of Greater Chicago to dispose of digested sewage sludge on Fulton County, Illinois, strip-mined land. Estimates are that about 150 dry tons of sludge/acre could be applied in the first ten years with another 100+ tons applied in the next ten years. The analysis shows that cropping systems using large amounts of sludge nitrogen are most desirable. R498

R73-150 PLANNED RECLAMATION

Thirgood, J. V. (Univ. British Columbia), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 92-97. Reclamation should start with planning the mining operation to minimize dirt handling and assure availability of original topsoil as final cover. Other considerations in a reclamation program are, "the previous and intended use of the mined land and surrounding area, the topography, the potential of the soil for supporting vegetation, the available mining equipment, the regional economy, human settlement and resource use patterns (current and projected), and the legal requirements." The author also urges the mining engineers and foresters or agronomists to become empathetic to each other's problems and responsibilities in order to improve the probability of achieving both an efficient mining operation and effective reclamation. R638

R73-151 STRIP MINING FOR COAL

Tompkins, D. C., Univ. Calif., Inst. Gov. Studies, Public Policy Bibliographies: 4 (1973). 86 pp. There are 669 references covering strip mining, acid mine drainage, reclamation of strip-mined land, and state and federal government activities relating to strip mining. R11

R73-152 STRIP-MINED WATERSHED HYDROLOGIC DATA ACQUISITION STUDY

Tschantz, B. A., Water Resour. Res. Cent., Univ. Tenn., Res. Rept. No. 35 (Aug. 27, 1973). 17 pp. NTIS, PB-223 558. This was an aerial photographic study made using infrared methods to define two small East Tennessee watersheds. The information is to be used for hydrologic and land-use purposes. Three flights were made covering 5,041 acres of watershed representing 847 acres of disturbed bench, slope, and slide areas. A list of 15 figures shows

R73-152 (continued)

the mapped areas and several pictures give the overall view of the watershed area. Low-level altitude infrared photography is useful for mapping and measuring strip-mine disturbed areas. R273

### R73-153 VALLEY CAMP EXPANDS RECLAMATION PROGRAM

Green Lands 3 (2), 10-12 (1973). The reclamation program of Valley Camp Coal Company includes water control and treatment and revegetation. Jour

### R73-154 VALLEY CAMP STANDARDIZES ALL SEAMS

Coal Mining Process. 10 (11), 32-35 (1973). This article describes the operations of several Valley Camp mines and emphasizes the attention paid to reclamation. The company also built 18 ponds for water treatment and these are drained and cleaned once a year. Backfilling is done with topsoil for planting and this work is directed by a trained biologist. Refuse disposal is unique in that it is combined with fly ash from two power plants. The mixture is spread and compacted. R232

### R73-155 EFFECT OF STRIP MINING ON WATER QUALITY

Vimmerstedt, J. P., Finney, J. H., and Sutton, P., Ohio Agr. Res. Develop. Cent., Wooster, Ohio, Rept. to Ohio State Univ., Water Resour. Cent., Columbus, Ohio, Jan. 1973. 54 pp. NTIS, PB-217 872. This report covers two separate topics, the effect of strip mining on water quality of Little Mill Creek, Ohio and infiltration of water on strip-mine spoil banks. Four sampling points were selected and used over a 236-week period. Results showed that manganese concentrations near the mining area exceeded standards 80 percent of the time while this same chemical in the creek not affected by mining exceeded standards only 13 percent of the time. Sulfate, magnesium, calcium, iron, aluminum, and hydrogen ion concentration were also monitored and found to have higher values in streamflow affected by strip mining. Objective of the second phase was to measure infiltration rates on spoil banks and to identify spoil characteristics associated with these variations in rates. Rates were higher on dry spoil than on wet spoil during the first 25 of the test runs, but later they were similar. 73-49

### R73-156 THE EFFECT OF HERBACEOUS VEGETATION ON SURVIVAL AND GROWTH OF TREES PLANTED ON COAL-MINE SPOILS

Vogel, W. G. (Northeastern Forest Expt. Sta.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 197-207. Establishing both trees and herbaceous vegetation is often desirable in the reclamation of strip-mine spoil banks. To study the effect of herbaceous competition with trees, grass alone and grass with legumes were sown concurrently with the planting of four

R73-156 (continued)

tree species on coal-mine spoils in southeastern Kentucky. After three growing seasons, the herbaceous vegetation, which had produced about 95 percent ground cover, did not significantly affect the survival of trees, but greatly suppressed their growth. However, in the fourth and fifth growing seasons, the growth of trees in the plots dominated by the legume exceeded the growth in plots with grass only and without herbaceous competition. Tree growth was suppressed the most by a cover of grass alone. (Author's abstract) R647

### R73-157 FERTILIZER AND HERBACEOUS COVER INFLUENCE ESTABLISHMENT OF DIRECT-SEEDED BLACK LOCUST ON COAL-MINE SPOILS

Vogel, W. G. and Berg, W. A. (Northeastern Forest Expt. Sta., USDA), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VI-5. pp 189-198. After one growing season, black locust seeded on plots fertilized with P averaged three to four times taller than those seeded on unfertilized plots. Adding N with P produced even greater growth. When fertilized, seeded herbaceous vegetation competes with seeded black locust. Competition is especially severe with species that make dense and rapid growth early in the spring. Competition is less severe when black locust is seeded with slower developing herbaceous species, or with species that grow in late spring and summer. (Authors' abstract) 631 H981

### R73-158 ENVIRONMENTAL CONTROL - SURFACE COAL MINED LANDS

Weimer, W. H. and Weimer, W. A., in "SME Mining Engineering Handbook," Vol. 2, A. B. Cummins and I. A. Given, Eds., New York: AIME, 1973. pp 17-145 - 17-147. This short section on the subject of reclamation includes a tabulated classification of strip-mine spoils. The three factors in the rating are class number and description, pH value, and extent of area. Strip-mined lands are divided into three broad groups and each is described. Spoil types are listed as calcareous sands and toxic clays. A detailed description of soil characteristics of materials which make up overburden is included. R622 A943

### R73-159 WEST VIRGINIA BREAKS RECLAMATION RECORD AGAIN

Green Lands 3 (3), 8-9 (1973). According to the statistics in this article, West Virginia has bettered its own record for acreage reclaimed. This is the fifth consecutive year West Virginia has led all other states in reclamation. Tonnage, surface mining, and respective totals of reclaimed acreage are compared for West Virginia, Kentucky, Ohio, Pennsylvania, Virginia, and Tennessee. Several pictures illustrate reclamation results. Jour

### R73-160 WEST VIRGINIA IS RECLAMATION LEADER FOR 5TH STRAIGHT YEAR

Green Lands 3 (1), 40-41 (1973). The West Virginia reclamation program

R73-160 (continued)

pictured is operated at no expense to taxpayers as it is supported by per-acre assessment on strip mine operators. Statistics given show that in the year July 1, 1971 through June 30, 1972, 27,332 acres of mined land were reclaimed in West Virginia. Jour

R73-161 FRACTURE MAPPING AND STRIP MINE INVENTORY IN THE MIDWEST BY USING ERTS-1 IMAGERY

Wier, C. W., Wobber, F. J., Russell, O. R., and Amato, R. V., Symp. on Significant Results Obtained from Earth Resour. Tech. Satellite-1: Vol. 1 Technical Presentation, Section A: Natl. Aero. & Space Admin. Rept. NASA SP-327 (1973). pp 553-560. ERTS-1 imagery and high-altitude infrared photography can be used to obtain data for fracture mapping in coal-bearing rocks in the attempt to prevent mine roof-fall accidents. ERTS-1 imagery also differentiates between undisturbed land and raw mined land or mined land planted but not graded. Land reclaimed to pasture and farming is difficult to detect. R569

R73-162 HEARING ON FEDERAL SURFACE MINING LEGISLATION, TESTIMONY OF THE WEST VIRGINIA SURFACE MINING AND RECLAMATION ASSOCIATION

Wilkinson, J. L. (President, W. Va. SMRA), Green Lands 3 (2), 42-43 (1973). The representative of the West Virginia Surface Mining and Reclamation Association reviews the extent, economic impact, and relation to deep mining of the surface-mining industry. R98

R73-163 CHANGED SPOIL DUMP SHAPE INCREASES STABILITY ON CONTOUR STRIP MINES

Williams, G. P., Jr. (Northeastern Forest Expt. Sta.), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 243-249. A survey of mines operating under Kentucky's 1966 regulations revealed that approximately 94 percent of the outslopes were stable. Of the 178 slides which occurred, nearly half involved spoils dumped in valleys. Slides occurred over the entire range of slopes; slide incidence and terrain steepness were not found to be related. Increased storage of spoil upon the excavated bench accounted for a 42-percent reduction in area disturbed by slides and a 17-percent reduction in total areal disturbance. The overall level of instability on spoil dump outslopes is still excessive, but this instability can be reduced as knowledge of the physical and mechanical properties of spoils and of site characteristics is accumulated and incorporated into mining and spoil placement techniques. (From author's abstract) R652

R73-164 PROTOTYPE NATIONAL MINED-LAND INVENTORY MAPS

Wobber, F. J., Earth Satellite Corporation, 1973. Three maps prepared from ERTS-1 imagery differentiate disturbed areas from surrounding vegetated areas. The maps are of Millport, Kentucky Quadrangle; Pike, Warrick, and Gibson Counties, Indiana; and Vincennes, Indiana. R570

R73-165 DESIGN PARAMETERS FOR RECLAMATION

Youngs, B. D., Green Lands 3 (2), 24 (1973). Planning the mining operation with the view of planning for reclamation is emphasized. Jour

R73-166 DESIGN PARAMETERS FOR RECLAMATION

Youngs, B. D., Am. Mining Congr., Coal Convention, Report on Coal Technology Vol. II, 1973. 8 pp. This paper is a short review of the reclamation problem and its future direction. The approach of considering reclamation as a part of the total planning of the mining operation is discussed at length. The major problem is economics. 662.6 A665

R73-167 FRIENDSHIP PARK--ONE USE OF RECLAIMED STRIP MINE LAND

Zande, R. D. (R. D. Zande & Associates), Natl. Coal Assoc./Bitum. Coal Res., Inc., First Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Pittsburgh, Pa. (1973). pp 294-303. The plans to turn 1,100 acres of strip-mined land in Jefferson County, Eastern Ohio into park lands are reviewed. The land was donated to the county by Hanna Coal Company, Cadiz, Ohio, a division of Consolidation Coal Company. An 85-acre lake for fishing and boating is being formed by construction of an earth-fill dam. An airport, picnic areas with shelters, and hiking trails are also included in the nearly completed Phase I of the project. Further recreational development is planned. The land reclamation is expected to improve the water quality of Little McIntyre Creek which receives the runoff from the new reservoir. R657

R73-168 USE OF FERTILIZERS TO SPEED PINE ESTABLISHMENT ON RECLAIMED COAL-MINE SPOIL IN NORTHEASTERN ALABAMA: II. FIELD EXPERIMENTS

Zarger, T. G., Bengtson, G. W., Allen, J. C., and Mays, D. A. (TVA), in "Ecology and Reclamation of Devastated Land," Vol. 2, R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper VI-7. pp 227-236. Applications of nitrogen and phosphorous fertilizer to seeded pine improved their growth and survival. 631 H981

R73-169 SEEDING OF PINE ON COAL SPOIL BANKS IN THE TENNESSEE VALLEY

Zarger, T. G., Curry, J. A., and Allen, J. C. (TVA, Div. Forestry, Fisheries Wildlife Develop.), in "Ecology and Reclamation of Devastated Land," Vol. 1,

R73-169 (continued)

R. J. Hutnik and G. Davis, Eds., New York: Gordon and Breach, 1973. Paper IV-8. pp 509-523. Tests were carried out at 38 sites on a total of 158 acres. Factors evaluated included time of seeding, area seeded, rate, seed treatment and species. Results showed that forestation could be accomplished by seeding as well as by hand planting of seedlings. 631 H981

### R73-170 MAPPING OF SPOIL BANKS USING ERTS-A PICTURES

Ahmad, M. U. (1), Kantner, D. A. (1), and Antalovich, J. W. (2) [(1) Ohio Univ. and (2) Kucera and Associates, Inc.], Proceedings of the 1st Panamerican Symp. on Remote Sensing, Panama City, April 27 - May 2, 1973. pp 111-123. A study of surface-mined and reclaimed lands in southeastern Ohio is described. R804

### R73-171 REVEGETATING COAL MINE SPOILS IN NEW MEXICO: A LABORATORY STUDY

Aldon, E. F. and Springfield, H. W., U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station, Forest Service Research Note RM-245 (June 1973). 4 pp. Emergence and early growth of mountain rye and fourwing saltbush were studied in untreated 3-year-old mine spoils, and in spoils to which organic matter or fertilizer had been added under greenhouse conditions. Emergence and growth were satisfactory from untreated spoils; adding amendments had no effect on seedling emergence or early growth. (Authors' abstract) CE263

### R73-172 THE NORTH DAKOTA SURFACE MINING CONTROL AND RECLAMATION LAW

Beck, R. E., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 109-118. The law, enacted in 1969, and its 1971 and 1973 revisions are discussed. 631 W17

### R73-173 A NOVEL APPROACH TO REASONABLE REGULATION OF STRIP MINING

Binder, D. (Ohio Northern University), University of Pittsburgh Law Review 34 (3), 339-374 (Spring 1973). After a discussion of surface mining and its environmental effects, experience of the states in regulating surface mining, and the results of much litigation over the regulations, the author advocates adoption of a simple statute allowing surface mining if the operator can show that "land can be reclaimed, siltation and water pollution problems eliminated, landslides prevented, highwalls restored to their original contours, fish and wildlife resources preserved, and the land made productive again." R870

### R73-174 ECONOMICS OF DOZERS IN RECLAMATION WORK FOR THE COAL INDUSTRY

Bullis, R. A. and Raivio, H. A. (International Harvester Company), presented at Research and Applied Technology Symposium on Mined-Land Reclamation, Pittsburgh, Pa., by Bituminous Coal Research, Inc., March 7-8, 1973. 16 pp.+ The economics and use of different pieces of equipment for earth moving in reclamation are determined by conditions which vary from mine to mine. This paper presents the results of an 18-month study of the cost per yard of earth moving in both area and contour mining operations in the Central and Midwestern states. R799

### R73-175 CONTAINER-GROWN SEEDLINGS SHOW POTENTIAL FOR AFFORESTATION OF PENNSYLVANIA COAL-MINE SPOILS

Davidson, W. H. and Sowa, E. A. (Northeastern Forest Experiment Station), Reprinted from Tree Planters' Notes 25 (4), 6-9. The purpose of the project was to determine whether containers could enhance the growth and survival of plants on coal refuse piles and surface mine spoils. Plastic-type tubes were subject to frost-heave and restricted lateral root development, so their use is not recommended. Seedlings grown in containers made from peat showed the best growth and survival in this two-year test. R901

### R73-176 AN HISTORICAL OVERVIEW OF STRIP MINE RECLAMATION IN NORTH DAKOTA

Dietrich, I. T., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 49-51. The first recorded attempt to reclaim coal mine spoil banks was in the 1930's by the North Dakota Game and Fish Department. Success in revegetation at the several mine locations has been quite variable due primarily to the great differences in chemical makeup and physical condition of spoil materials. Leveling and placing topsoil on top of the leveled material aids greatly in revegetating a spoil area. (Author's abstract) 631 W17

### R73-177 ENVIRONMENTAL IMPLICATIONS OF DEVELOPING OUR COAL RESERVES

Gwynn, T. A., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 87-107. The author emphasizes the need for use of coal as a source of energy, the environmental and socio-economic impacts of coal resource development, and points out that the coal industry must work with others in developing regulations for mining and reclamation and should publicize the long-standing and continuing industry programs of reclamation. The author has attached a summary of state surface mining and reclamation laws as of 1973, and tabulations of the various reclamation costs of the Knife River Coal Company. 631 W17

R73-178 ENVIRONMENTAL IMPACT OF STRIP MINING: THE ECONOMIC AND SOCIAL VIEWPOINT

Hertsgaard, T. A. and Leistritz, F. L., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 73-85. The economic and social implications of strip mining in North Dakota depend to a great extent on the related economic activity that is associated with lignite mining. If the lignite is shipped from the state for use elsewhere, the principal environmental issue involved is the degree of reclamation of the spoil banks. Current market value of farmland in the lignite mining area ranges from $50 to $150 per acre. Reclamation costs to restore the land to its premining state are estimated to range from $700 to $900 per acre. The economic justification for expenditures of these magnitudes would require that the value of future uses of these lands (including aesthetic values) be several times the level currently registered (for agricultural uses) by the market. If the lignite is converted to other forms in North Dakota, the impact on the area could be much greater than if the lignite is shipped from the state. Gasification plant (and possible satellite industry) development could also generate massive increases in employment and population in the area. This could lead to significant social and economic adjustment problems. (Authors' abstract) 631 W17

R73-179 PRESENTATION

Kowal, S. W. (Allis-Chalmers Corporation), to First Research and Applied Technology Symposium on Mined-Land Reclamation, Pittsburgh, Pennsylvania, by National Coal Association and Bituminous Coal Research, Inc., March 1973. 6 pp. The development of large dozer tractors and their use in earth moving for surface-mine reclamation are discussed. R859

R73-180 INDUSTRY'S ROLE IN RECLAMATION FOR RECREATION

Krause, R. R., National Conference, Surface-Mined Land for Outdoor Recreation, Washington, D.C., by U.S. Department of the Interior, Bureau of Outdoor Recreation, May 14, 1973. 8 pp. The potential and use of strip-mined lands for recreation are discussed. The types of facilities vary from final-cut pits that become fishing lakes, otherwise unreclaimed areas that become wildlife refuges after the growth of volunteer vegetation, to planned picnic and camping areas as exemplified by Friendship Park in Ohio. R853

R73-181 THE PRAIRIE PLAN

Kudrna, F. L. (The Metropolitan Sanitary District of Greater Chicago), J. Urban Planning Develop. Div. Amer. Soc. Civil Eng. 99 (UP2), 205-215 (Sept. 1973). In an experimental project, sewage sludge from the Chicago area has been applied as liquid fertilizer to surface-mined land in Fulton County, Illinois, two hundred miles away. Demonstration plots showed that the applications improved plant growth. Part of the study area was developed for recreation. Costs of the project are summarized. R753

R73-182 ENVIRONMENTAL IMPACT OF SURFACE MINING: THE BIOLOGIST'S VIEWPOINT

Morgan, R. L., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 61-71. The author discusses the environmental impact of all types of surface mining in the United States and covers the effects on fish and wildlife of mining sand, gravel, clay, stone, and lignite in North Dakota in somewhat more detail. 631 W17

R73-183 A GEOLOGIST'S VIEW OF STRIP MINING

Noble, E. A., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 53-60. In overview, the geologist sees strip mining as a unique but relatively minor disturbance of a small portion of the earth's surface and near surface. From the perspective of geologic time, the effects of strip mining could be considered minor: topography would be little changed, effects on regional ground-water flow would be minor, and other physical and geochemical effects would eventually be mitigated. (From author's abstract) 631 W17

R73-184 CHEMICAL SOIL STABILIZERS FOR SURFACE MINE RECLAMATION

Plass, W. T. (Northeastern Forest Experiment Station), in Soil Erosion: Causes and Mechanisms; Prevention and Control, Proceedings of a Conference-Workshop, Washington, D.C., by Highway Research Board, National Research Council and National Science Foundation, HRB Special Report 135, Jan. 26, 1973. pp 118-122. Two cooperative demonstrations compared vegetation establishment and erosion loss following 30 treatments with six mulches and 12 soil stabilizers. There is no evidence that these materials are necessary for vegetation establishment; they are used primarily to control erosion. Mulch, soil stabilizer, and soil stabilizer-mulch treatments were effective. (From author's abstract) R895

R73-185 LIGNITE MINE SPOILS IN THE NORTHERN GREAT PLAINS--CHARACTERISTICS AND POTENTIAL FOR RECLAMATION

Sandoval, F. M., Bond, J. J., Power, J. F., and Willis, W. O., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 1-24. This paper was also presented at the First Research and Applied Technology Symposium on Mined-Land Reclamation. See R73-129. 631 W17

R73-186 STATEMENT ON BENEFIT/COST EVALUATION OF STRIP MINING IN APPALACHIA

Schmidt-Bleek, F. K. and Moore, J. R., University of Tennessee, Appalachian Resources Project, prepared for U.S. House of Representatives, Committee on Interior and Insular Affairs, Subcommittee on the Environment and Subcommittee

R73-186 (continued)

on Mines and Mining, April 17, 1973. 25 pp. NTIS, PB-283 391/1WN. Preliminary results of economic studies reported by the authors cover flood damage, loss of farm income, and differential human capital costs in deep and surface mining. CE518

## R73-187 USE OF ABANDONED STRIP MINES FOR SOLID WASTE DISPOSAL IN MARYLAND

Maryland Department of Health and Mental Hygiene, Division of Solid Waste Control, Report to U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Grant Number G06-EC-00048, June 1973. 193 pp. The demonstration project in western Maryland, carried out at one site for five years and at the second site for one year, showed the economic and technical feasibility of using abandoned strip mines for solid waste disposal by sanitary landfill techniques. The hydrogeology of the areas was studied and provisions were made for continuing collection of hydrogeological, chemical, microbiological, and settlement data. These studies showed that there were no public health problems from the sanitary landfill. Progress of plant growth from grasses and legumes seeded on the completed portions of the landfill indicated that watering might be needed to establish vegetation in dry weather. The appendix includes the mechanics of operating the landfill, cost data, job descriptions, laws of Maryland pertaining to strip mining and control of drainage from abandoned mines, the report on hydrology and geology, water sampling program, and acid mine drainage studies. CE301

## R73-188 ECOLOGY OF SOME MINED AREAS IN NORTH DAKOTA

Wali, M. K. and Freeman, P. G., in Some Environmental Aspects of Strip Mining in North Dakota, M. K. Wali, Ed., North Dakota Geological Survey, Educational Series 5 (1973). pp 25-47. Plant species diversity and abundance and the physical and chemical characteristics of mined and unmined soils were studied in the coal-bearing area in western North Dakota in 1972 and 1973. The purpose was to compare unmined areas to spoil banks that have naturally revegetated along a time gradient of 0-53 years. Data obtained on 27 soil variables from 4 depths of a profile, representing the effective zone of rooting depth, revealed significant differences between the mined and unmined sites. Species diversity was considerably higher at unmined sites. Mined sites, including even the oldest spoil banks, showed sparser vegetation and a reduced growth form and vigor of plant species. Generally, the mined sites showed higher pH, electrical conductivity, replaceable magnesium and sodium, total phosphorus and sulfur, EDTA-extractable strontium and copper, and percent silt+-clay. The unmined sites were higher in organic matter, replaceable potassium, and EDTA-extractable manganese. The maximum variability existed in the upper 30 cm of soil. Although salinity due to sodium is a serious problem in the revegetation and reclamation of these spoil materials, this study shows that high magnesium levels may be an added problem. (From authors' abstract) 631 W17

R73-189 NEW TOOLS AND TECHNIQUES FOR RECLAIMING LAND: A MANUFACTURERS VIEWPOINT

Zillman, R. L., National Coal Association and Bituminous Coal Research, Inc., First Research and Applied Technology Symposium on Mined-Land Reclamation, Pittsburgh, Pennsylvania, March 7-8, 1973. (4 pp). This short presentation emphasizes the constraint of economics on the manufacturer of earth-moving equipment if he is the sole developer of new machinery for reclamation, and does not have the cooperation and backing of government and the mining industry. R959

## 1974

R74-1 COAL MINING AND ITS EFFECT ON WATER QUALITY

Ahmad, M. U. (Ohio Univ.), in "Extraction of Minerals and Energy: Today's Dilemmas," R. A. Deju, Ed., Ann Arbor: Ann Arbor Science Publishers, Inc., 1974. pp 49-56. The effect on water quality of both surface and underground mining is discussed. The hydrology of the Sheban Mine, Mahoning County, Ohio is used as an example of a typical strip mine. 631 D32

R74-2 MULTIPLE SEAM CONTOUR BACKFILLING

Allen, N., Jr. and Long, W. J., Green Lands 4 (1), 17-18 (1974). The experimental mining begun in 1972 on Massengale Mt., Campbell County, Tenn., is described. Costs are given for backfilling and hauling extra spoil off-site, and for lost production resulting from the method. Reclamation costs of grading and revegetation are estimated to be less using this method. Jour

R74-3 AT AMAX, ENVIRONMENTAL ENGINEERS FIND BETTER USES FOR RECLAIMED LAND

Coal Age 79 (10), 132-135 (1974). Amax Coal Co. plans for land use at its new Catlin mine include housing, a business and shopping center, several lakes, a golf course and a public park. The company has an environmental engineering group which makes a complete study of projects, including legal permits and writing all required reports after obtaining necessary environmental data. They prepare a "baseline study" which may cost $200,000 or more. Continuous monitoring must also be maintained to insure compliance with all regulations. Jour

R74-4 SURFACE MINING LEGISLATION: THE CASE FOR TRUTH IN PACKAGING

Bagge, C. E. (NCA), 1974 Directors Conf., Natl. Rural Electric Cooperatives Assoc., New Orleans, La., Jan. 8, 1974. 9 pp. Mr. Bagge discusses in detail the strangling effects the proposed coal legislation will have on the coal industry, the unpracticability of the reclamation requirements forcing underground mining while preventing surface mining. The politicians have not used the true figures to prepare their case. He blames the energy shortage on

R74-4 (continued)

irresponsible environmentalists. Their regulations will prevent mining of about half the low sulfur coal in the western states, and have caused untold conversions thereby eliminating use of great tonnage of eastern coals for the sake of a little sulfur in the stacks. R329

R74-5 '40S LOOK IS NO LONGER IN STYLE ON STRIP JOBS

Baisden, H. L., Green Lands 4 (3), 3-5, 7 (Fall 1974). Various new ways of handling strip-mine waste material are compared with the practices of the 1940s and '50s in the Annual Interagency Evaluation of West Virginia Strip-Mined Lands. The results of new methods and also the revegetation efforts are illustrated. The author uses examples of many coal operators in describing the various pieces of equipment suitable for steep slopes and hilly areas. The problems of water control and handling sediment are also discussed. Jour

R74-6 A VENTURE INTO RECLAMATION

Balzer, J. L. (Utah International Inc.), Am. Mining Congr. Convention/Exposition, Las Vegas, Nev., Oct. 7-10, 1974. 12 pp. The reclamation program of Utah International Inc. which operates the Navajo mine near Farmington, New Mexico began in 1966. The work was coordinated with ash disposal of the Four Corners generating plant. Studies were set up to test the ability of overburden to support vegetation and to evaluate the use of mulches, soil amendments, and irrigation, and the growth potential of numerous species. Native plants fared better than non-native plants and supplemental irrigation proved necessary. At least two years are required to evaluate a reclamation program and to find out whether planting will maintain itself. The information will be used in planning reclamation of regraded land to support grazing. 662.6 A665

R74-7 CABIN CREEK - AN ACCUMULATION OF UNPAID SOCIAL AND ENVIRONMENTAL COSTS IN APPALACHIA

Baumgardner, R. G. and Steiner, D. E., Water Spectrum 6 (2), 32-38 (1974). A project planned by the Corps of Engineers in the Cabin Creek area of West Virginia, an area affected by mining, particularly strip mining, will be concerned with the major problems of water control and land reclamation as well as other socio-economic problems of the area. R542

R74-8 USE OF SOIL LABORATORY ANALYSES IN REVEGETATION OF MINED LANDS

Berg, W. A. (Colo. State Univ., Fort Collins), Am. Mining Congr. Convention/Exposition, Las Vegas, Nev., Oct. 7-10, 1974. 7 pp. The factors that influence the success of revegetation efforts on mined land are phosphorus and nitrogen; acidity and pH; soil texture and excess soluble salts including sodium. Sampling techniques on disturbed lands and the use of core sampling

R74-8    (continued)

are described.  662.6 A665

R74-9    THE DEPARTMENT OF THE INTERIOR'S COAL-LEASING PROGRAM

Berklund, C. (Bur. Land Management, USDI), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 34-35. The government's policy on Federal coal leasing recognizes the energy problem, stresses maximum environmental protection for resource development, and has the intent of complying with all requirements of the National Environmental Policy Act, including the preparation of Environmental Impact Statements.  R667

R74-10    NEW CITIES FOR APPALACHIA--WILL THEY BE DENIED?

Blakely, J. W., Coal Mining Process. 11 (1), 49-54 (1974). A feature of this article is a foldout showing a proposed community developed on a six-mile-long plateau made from stripping hill tops and filling valleys. The proposed use of a 53-acre plateau for a high school and some residential development is also shown.  R305

R74-11    SURFACE MINING IN APPALACHIA

Blakely, J. W., Coal Mining Process. 11 (6), 36-39 (1974). Three mining companies operating in the steep hills of Kentucky are recovering more coal and working in steeper areas than formerly possible. In addition, they are creating safe access roads, and using "valley fill" and "head of the hollow" methods to provide level areas for needed pasture and housing areas.  R484

R74-12    THE DAVIS PROJECT - FROM BLACK TO BLUE

Blizzard, S. H. and Shaffer, S. L., Green Lands 4 (3), 13-16, (Fall 1974). In the small community of Davis, West Virginia, apples, blueberries, blackberries, grapes and raspberries were grown on reclaimed land. Blueberries thrive on areas of low fertility, low pH, limited water and minimum organic matter, and the other fruits need either organic matter or lime. Sawdust was used for organic matter, supplied together with excess nitrates, and very good yields were obtained. Current research is being done to determine which varieties of the various fruits are most suitable to this area.  Jour

R74-13    BENEFITS AND COSTS OF SURFACE COAL MINE RECLAMATION IN APPALACHIA

Bohm, R. A., Moore, J. R., and Schmidt-Bleek, F. (Univ. Tenn.), Appalachian Resour. Proj. ARP Publ. No. 27 (undated, for publication 1974). 7 pp. The cost/benefit analysis of reclaiming steep-slope surface mines is based on conditions in five watersheds in the coal mining region of Tennessee, and on

R74-13 (continued)

reclamation costs for several alternative slopes and bench widths with overburden stored on the outslope prior to backfilling. R576

### R74-14 LAND REHABILITATION: PROMPT PASSAGE OF FEDERAL RECLAMATION LAW RECOMMENDED BY FORD FOUNDATION STUDY

Box, T. W. (Utah State Univ.), Coal Age 79 (5), 108-111, 113-115, 117-118 (1974). The recommendations of the study are discussed in relation to the environment of the western coal lands. Jour

### R74-15 OBSERVATIONS ON THE SURFACE MINING OF COAL

Breslin, J. J. and Anderson, R. J. (Battelle Memorial Inst., Columbus, O.), A Battelle Energy Program Rept., 1974. 94 pp. This extensive survey was carried out by a team from mining and related fields. The team visited 24 surface- and underground-mine sites in this country and 2 in Germany. The report "attempts to provide a brief, substantially non-technical, overview of the way in which the feasibility of opening a surface mine is currently established and of the approaches being employed in planning and operating a mine and in the subsequent reclamation work." Battelle

### R74-16 AN ANNOTATED BIBLIOGRAPHY OF THE SURFACE-MINED AREA RESTORATION RESEARCH PROJECT

Caldwell, N. B., Northeastern Forest Exp. Sta., U.S. Dept. Agr., Sept. 1974. 22 pp. This annotated bibliography includes a total of 81 references and an author index. R587

### R74-17 COMPREHENSIVE PLANNING FOR MINERAL RESOURCE DEVELOPMENT IN THE POWDER RIVER BASIN: A PROPOSAL

Calhoun, D., Ackerman, W., and Montgomery, E. (Bur. Land Management), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 69-75. The present Bureau of Land Management system for managing resources, such as those in the Powder River Basin in southeastern Montana and most of northeastern Wyoming, is described. The planning system includes Resource Analysis, Management Framework Plan which gives information to evaluate alternative development plans, and a Management Action Plan--Multi-Year Programming which identifies specifications and is the basis for budget requests and justification documents. Also a part of the planning process is Energy Minerals Allocation Recommendation System which puts the area or resource into a broader regional or national point of view. R670

### R74-18 SOIL-MAKING POTENTIAL OF POWER PLANT FLY ASH IN MINED-LAND RECLAMATION

Capp, J. P. and Gillmore, D. W. (Bur. Mines MERC), in "Ash Utilization," Proc. Third International Ash Utilization Symp., Pittsburgh, Pa., 1973, U.S. Bur. Mines IC 8640, 1974. pp 258-268. The use of fly ash in restoring surface-mining spoils and coal-waste dumps is related to the alkaline character and ability to neutralize acid soils, the addition of mineral nutrients, their positive effect on the moisture-holding capacity of soils, and decrease in soils bulk density. Plants growing well on fly-ash-treated spoils are listed. Costs of using fly ash are also estimated. R493

### R74-19 SURFACE MINED LAND IN THE MIDWEST - A REGIONAL PERSPECTIVE FOR RECLAMATION PLANNING

Carter, R. P., LaFevers, J. R., Croke, E. J., Kennedy, A. S., and Zellmer, S. D., Argonne National Laboratory, Rept. to U.S. Bur. Mines, Open File Rept. 59-74 (June 1974). NTIS, PB-237 830. This comprehensive study of surface mining and reclamation in the eleven-state Midwest area has separate chapters on Indiana, Illinois, Western Kentucky, Missouri, and Ohio. Each chapter includes an extensive discussion of current legislative requirements for mining and reclamation, history of surface mining, geologic and physiographic conditions, surface conditions, mining operations, coal markets, coal reserves, disturbance descriptions, and bibliographies. 631 A6

### R74-20 CHECKING THE IMPACT OF MINING

An SCS Environmental Quality Aid, Preprinted from Soil Conservation Magazine, Soil Conserv. Serv., USDA (undated). 14 pp. Seven short articles appearing in issues of the magazine from Jan. 1968 through Jan. 1973 are brought together in this reprint. Included in this general presentation are coal-mined lands in West Virginia, Colorado and Pennsylvania. R501

### R74-21 IN WEST VIRGINIA HILLS...IT'S HAULBACK MINING ALL THE WAY

Chironis, N. P., Coal Age 79 (11), 60-64 (1974). This article describes the operation of strip mining by the Princess Susan Coal Company of Charleston, W. Va. Detailed diagrams and pictures illustrate how the haulback method is used to handle overburden, leaving essentially no highwall. Although more equipment is required for this system than for conventional methods, haulback mining reduces bondable acreage, helping to justify the extra expense. Water control is effective and in line with state standards. A list of needed equipment is included as well as the numbers and kinds of trees planted. R545

### R74-22 WEST VIRGINIA HAULBACK METHOD--A MODERN WAY OF SURFACE MINING

Chironis, N. P., Coal Age 79 (1), 66-68 (1974). The Grafton Coal Co. of

R74-22 (continued)

Clarksburg, W. Va. uses a strip-mining method which virtually eliminates pushing overburden over the hill. Initial cut material is placed in a low hollow area. Then a second block is started and this material is placed in the first after the coal has been removed. The process is repeated and finally the material taken from the original area is used to fill the last block and nothing goes over the hill. The method also eliminates the need to build ponds and other water-control construction since the bench design provides good watershed area. Jour

R74-23 CHOOSING THE RIGHT HAULAGE VEHICLE

Coal Mining Process. 11 (8), 46-48, 50, 52 (1974). Advantages and disadvantages of scrapers, trucks, and wheel loaders in handling overburden with controlled placement of spoil in contour mining are discussed. R531

R74-24 THE BRITISH EXPERIENCE IN MINED-LAND RECLAMATION AND PREPLANNING OF MINERAL WORKINGS

Clouston, J. B. (Brian Clouston & Pts, Durham, England), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 217-241. The British government has been giving increasing attention to social problems caused by the waste heaps and other surface-mining disturbed areas. In the Durham area, there were about 600 major mine workings, each with its own spoil heap. The government has instituted extensive rehabilitation programs to grade and reclaim these many unsightly refuse piles, some of which are over 100 feet high. The National Coal Board has reclaimed more than 120,000 acres from strip mining in the past thirty years. Several case histories of reclaimed "derelict land" are included. R685

R74-25 ALABAMA OPERATORS ORGANIZE FOR BETTER RECLAMATION

Cornforth, C., Coal Mining Process. 11 (7), 41-42, 51-53 (1974). The Alabama Surface Mining Reclamation Council was founded July 1, 1972. Operators organized to set their own reclamation standards and now aim to re-timber their mined land although some grazing area has been developed. The Council is investing $150,000 in a 5-year research grant awarded to Auburn University Agricultural Experiment Station. R491

R74-26 SURFACE MINE OF THE FUTURE

Cornforth, C., Coal Mining Process. 11 (1), 75-78, 87-90 (1974). This article describes a new method of mountain mining. Oversized equipment is used to remove over 10 million tons of overburden yearly. This operation creates large flat areas for grazing and planting. A survey before mining locates a suitable hollow for the overburden. Such coal reserves were unrecoverable

R74-26 (continued)

several years ago before the development of the big trucks and loaders. Mention is also made of the new strip-mining law which may prohibit surface mining of a large fraction of Montana and Wyoming. There is also a difference of opinion on how much recoverable reserves exist today. Government uses significantly lower estimates than industry figures to document a claim that strip mining is unnecessary. R306

R74-27 WASHINGTON COAL MINE FUELS FIRST NW STEAM ELECTRIC PLANT

Cornforth, C., Coal Mining Process. 11 (10), 32-35, 52-54 (1974). The reclamation and the mining methods at the Centralia Coal Mine are described. Revegetation is not a problem especially when nitrogen and phosphorus are used in fertilizing. Siltation is the greatest problem and it is controlled by flocculating the near-colloidal clay particles. The area will be reclaimed mainly to timber as well as to forage crops. R592

R74-28 WYOMING MINE COMPLEX PROTECTS AREA LIFESTYLE

Cornforth, C., Coal Mining Process. 11 (3), 26-29, 50 (1974). Amax Coal Co., near Gillette, Wyoming, operates one of the early western mining projects in low-sulfur coal. In reclaiming the property, spoil material was mixed with soil and planted with numerous grasses. Rainfall which is 15 inches per year is considered adequate for the restoration process. In this long-term reclamation program, a 100-acre area will be obtained for overburden removal, and for every 10 acres mined, 10 acres will be reclaimed with seeding done every spring and fall. R444

R74-29 NATURAL BEAUTY CONSIDERED

Daley, D. D., Mining Eng. 26 (2), 30 (1974). The total amount of coal mining and reclamation in the United States is briefly summarized. R405

R74-30 DESIGN OF SURFACE MINING SYSTEMS IN EASTERN KENTUCKY:
VOLUME I - SUMMARY

Mathematica, Inc. and Ford, Bacon & Davis, Inc., Engineers, Rept. to Ky. Dept. Natural Resour. Environ. Protection and Appalachian Regional Comm., ARC-71-66-T1 (Jan. 1974). 98 pp.+ The viewpoints of environmentalist coalitions, the regulatory agency, and the surface mining industry are summarized to provide perspective on the kinds of issues that motivated this study. Also included is a detailed summary of the relevant characteristics of surface mining and regulation in 1971-72, including industry characteristics, economics, and mining practices; regulatory procedures and results; and environmental impacts. Progress to date in mining, regulation, and reduction of environmental impact is summarized, and areas where further progress is needed are identified. Recommendations for modernizing and improving existing regulatory and mining

R74-30 (continued)

practices conclude the Volume. (Author's abstract adapted) 631 K37

### R74-31 AVOID PROBLEM SPOILS THROUGH OVERBURDEN ANALYSIS

Despard, T. L., Northeastern Forest Expt. Sta., U.S. Dept. Agr., Forest Serv. Gen. Tech. Rept. NE-10 (1974). 4 pp. Overburden analysis through core sampling can guide reclamation planning. A mining operation of the Jellico coal seam in eastern Kentucky is used as an example of how pre-mining study could have prevented the wide variation in pH of the spoils left after mining. Color, pyrite, and pH are suggested as field guides for identifying potentially toxic strata which should be evaluated by laboratory tests. R599

### R74-32 THE COST OF COAL - SURFACE MINING

Dials, G. E. and Moore, E. C., Appalachia 8 (2), 15-29 (Oct.-Nov. 1974). Both costs of reclamation and social cost are included in this general discussion of mining costs. R555

### R74-33 MINED LAND RECLAMATION ON THE NORTHERN GREAT PLAINS-INDIAN HEAD MINE

Dudley, T. E. and Becker, J. L. (North American Coal Corp.), Am. Mining Congr. Convention/Exposition, Las Vegas, Nev., Oct. 7-10, 1974. 14 pp.+ The climate, soils, geology, hydrology, vegetation, and wildlife of the Northern Great Plains region are described. In summarizing the mining and reclamation projects of the North American Coal Corp., it is pointed out that for about three years reclamation has been carried out on 3 acres for every acre mined. Reclamation research is also being carried out at the mine by USDA Agricultural Research Service, North Dakota State Univ., and Montana Agricultural Experiment Station. 662.6 A665

### R74-34 STREAM WATER CHEMISTRY OF MODEL RECLAMATION OF STRIP-MINED LAND

Elzam, O. E. (Case-Western Reserve Univ.), in "Extraction of Minerals and Energy: Today's Dilemmas," R. A. Deju, Ed., Ann Arbor: Ann Arbor Science Publishers, Inc., 1974. pp 211-230. In a reclamation project at an experimental strip-mine site of 60 acres in Guernsey County, Ohio, about one mile north of Fairview, three hills of about 20 acres each were formed. Topsoil removed prior to mining was spread evenly over one hill. Two hills were terraced, one with and one without topsoil. All three hills were seeded. The water-sampling program was set up so that the effect of reclamation on water quality could be evaluated and could be compared to water quality from undisturbed as well as partially reclaimed land. The results of the study showed that a combination of burying acid-producing materials, land terracing, and topsoil application resulted in fast revegetation, reduction of erosion and improvement in water quality. 631 D32

R74-35 ENERGY AND THE ENVIRONMENT

Surface Mining Research Library, Charleston, W. Va. (undated). 32 pp. This booklet is a pictorial presentation of strip-mining operations and reclamation work. Color pictures show the results of revegetation for grain, pasture, and timber purposes. Two examples of commercial use are shown. The final group of pictures shows the various types of damage caused by strip mining. Organizations favoring and opposing surface mining are listed. R250

R74-36 ENGINEERS HANDBOOK ON STRIP MINING IN EASTERN KENTUCKY

Commonwealth Ky., Dept. Natural Resour. Environ. Protection, T. D. Harris, Comm. (undated, issued 1974). 60 pp.+ This manual includes map requirements for strip-mining permits; Surface Mining Sediment and Water Quality Control Handbook; and a sample design of an eastern Kentucky debris basin. R482

R74-37 GLOSSARY OF SURFACE MINING AND RECLAMATION TECHNOLOGY

Compiled by Bituminous Coal Research, Inc.; Edited by Council for Surface Mining and Reclamation Research in Appalachia; published by National Coal Association, 1974. 25 pp. The words and terms in this glossary apply to mine drainage, strip-mine reclamation, and coal-waste disposal and are arranged in alphabetic order. R544

R74-38 RECLAMATION PROBLEMS IN SURFACE MINING

Grandt, A. F., Mining Congr. J. 60 (8), 29-32 (1974). The author, Director of Land Use and Reclamation for Peabody Coal Company, discusses the problems of reclamation including legislation, topsoil removal and replacement, overburden analysis, grading, climate and precipitation. A number of towns now have good water supply as a result of lakes and reservoirs built by Peabody's reclamation. The study of hydrology on the Black Mesa by University of Arizona, College of Agriculture, Dept. of Watershed Management is also noted. R511

R74-39 SURFACE MINING, LAND RECLAMATION, AND ACCEPTABLE STANDARDS

Greenbaum, M. E. and Harvey, C. E., College of Business and Economics, Univ. of Ky., Rept. to Inst. Mining Miner. Res., Univ. Ky., 4KY TR 83-74-IMMR3 (June 1974). 40 pp. NTIS, PB-234 254. This report was compiled as a result of efforts directed toward the identification of immediate problems involved in expanding coal production. This paper proposes an alternative to the reclamation tax. The performance bond system, already used by many coal mining states, is discussed, along with policy implications that arise from efforts to internalize external costs. The theoretical framework of the externality problems is also explored. (From author's abstract) R601

## R74-40 WEST VIRGINIA'S CONTROLLED PLACEMENT

Greene, B. C. and Raney, W. B. (W. Va. Dept. Natural Resour., Div. Reclamation), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 5-17. The three methods of "controlled placement" of spoil described are valley fill, mountain top removal with valley fill, and lateral movement. Each method permits controlled drainage and control of steepness of the exposed slope. The first two methods also produce level land suitable for a number of kinds of development. With "lateral movement" the first cut is placed either on an old strip mine bench or in a valley meeting the specifications for a "valley fill." Placement of succeeding cuts is carefully planned so that the reclamation closely follows the mining. Each method and its environmental advantages are discussed in detail. R663

## R74-41 ENVIRONMENTAL PROTECTION IN SURFACE MINING OF COAL

Grim, E. C. and Hill, R. D. (EPA, Natl. Environ. Res. Cent., Cincinnati, O.), U.S. EPA Environ. Protection Technol. Ser., EPA-670/2-74-093 (Oct. 1974). 277 pp. This comprehensive report covers all phases and problems of the strip-mining operation, including premining planning, sediment and erosion control, reclamation, and acid mine drainage. A glossary of terms and a summary of state surface-mining and reclamation laws in effect June 1, 1974 are also included. R554

## R74-42 FIELD CLUES USEFUL FOR CHARACTERIZATION OF COAL OVERBURDEN

Grube, W. E., Jr. and Smith, R. M. (W. Va. Agr. Expt. Sta.), Green Lands 4 (1), 24-25 (1974). Methods for identifying different spoil types in the field are discussed and are summarized in a "Condensed Guide to Field Clues." Jour

## R74-43 RECLAMATION PROCESSES IN THE WESTERN COAL MINES

Gwynn, T. A. (Knife River Coal Mining Co.), AIME Ann. Meet., Dallas, Tex., Feb. 25-28, 1974. Preprint No. 74-F-82. 35 pp. This paper itemizes all the western strip mines. These are in Arizona, Colorado, Montana, New Mexico, North Dakota, and Wyoming. Several of the reclamation laws are discussed and the variations from laws in the east are explained. Extensive tabulated information covers comparison of state statutory requirements regarding rehabilitation of surface-mined lands in the western United States as well as costs of earth moving and reclamation to achieve certain slopes. AIME

## R74-44 CHANGING METHODS AND EQUIPMENT USE IN APPALACHIAN SURFACE COAL MINING

Haley, W. A. (Caterpillar Tractor Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 193-203. The conventional method of contour strip

R74-44 (continued)

mining, where overburden was cast down the hill and stacked along the outer slope of the bench, is compared to the newer and more effective techniques, such as haulback, block cut, valley fill, and mountaintop leveling. Charts show relative costs of different mining methods and loading and hauling costs of representative machines. The conditions on which the cost estimates are based are described. R683

### R74-45 RECLAMATION OF STEEP SLOPE SURFACE MINING

Hamilton, L. W., Jr., Green Lands 4 (3), 8-10 (Fall 1974). Steep slope mining is done in West Virginia on inclines between 40 and 70 degrees by "controlled placement" of spoil. Continuous mining is possible while eliminating highwalls. No overburden is allowed to be placed on slopes greater than 28 degrees or 50 percent. A complete drainage system must be engineered which includes silt ponds, silt retarding dams and acid treatment facilities. Spillways are riprapped with large stones to prevent washouts. Gabion structures are used (baskets filled with 3-in. x 10-in. limestone rocks) for water retention. All operations must be inspected and approved. The author estimates that as much time and money is now spent in preplanning and reclamation as is spent in mining the coal. Jour

### R74-46 RECLAMATION IN STEEP SLOPE SURFACE MINING

Hamilton, L. W., Jr., Mining Congr. J. 60 (9), 111-14 (1974). Factors which are important in reclamation work on steep slopes include an acceptable drainage system, the use of Gabion dams, valley fill or head of hollow fill requirements, material handling which eliminates highwalls, timing problems in mining multiple or split seams, and revegetation. A series of pictures illustrate the methods described. In the state of West Virginia, reclaimed land is not released from bond for two seasons. R528

### R74-47 SANDSTONE WEATHERING ON SURFACE MINE SPOIL

Heald, M. T. (1), Arnold, G. E. (2), and Smith, R. M. (1) [(1) W. Va. Univ. and (2) Consolidated Gas Co.], Green Lands 4 (3), 19-20 (Fall 1974). (W. Va. Agr. Expt. Sta., Scientific Article No. 1317). Differences in sandstones are described. The strong aggregate can be used when stability is required and easily weathered sandstones are useful in providing soil. Differences in weathering characteristics can mainly be determined by observation. Jour

### R74-48 MEETING THE CHALLENGE OF RECLAMATION

Everett, H. W., Foster, C. A., and Hines, B. J. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 101-105. This paper discusses the surface mining and reclamation of disturbed lands

R74-48 (continued)

in Kentucky, and grasses, legumes, and trees suited to specific areas. As a detailed and more comprehensive guide, the authors recommend "The Kentucky Guide for Classification, Use and Vegetative Treatment of Surface Mine Spoil." This publication contains extensive information on alternative land uses, characteristics of many shrubs, trees, and ground covers, together with environments most suitable to each. Detailed data are tabulated and a glossary of terms for the industry is included. R673

## R74-49 RECLAMATION OF COAL-MINED LAND IN POLAND

Strzyszcz, Z. (1), Harabin, Z. (1), and Hutnik, R. J. (2) [(1) Polish Acac. Sci. (2) The Pa. State Univ.], Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 242-252. A surface mining problem relating to deep mining results from sand being mined to stow into underground mines to minimize surface subsidence. Problems with establishing trees on the worked out sand pits are with air pollution which discourages the use of Scotch Pine, the original forest cover, and the fact that the site may be too wet. Since water is scarce in the area, some of the sand pits are also used as central dumping areas for coal refuse from a group of mines. Considerable information has been gained in Poland from long-term studies on vegetation of coal refuse piles. A characteristic of the refuse is that sodium and magnesium salts are present in much greater amounts than calcium salts. Brown coal is surface mined in three areas having overburden with different properties. The reclamation of these areas to forest or agricultural land or to water storage is based on research and experiments conducted over a number of years. Basic studies still continuing are reviewed. The hydrological disturbances caused by mining are considered to be an important unsolved problem in Poland. R686

## R74-50 BRITISH BOAST OF EXCELLENT LAND RESTORATION PROGRAM

Ironman, R., Coal Mining Process. 11 (11), 36-40, 59 (1974). This article describes opencast mining in Great Britain and the detailed British reclamation procedures. The National Coal Board carries out reclamation, usually buying the area or making a lease arrangement. Ultimate uses of reclaimed land include agriculture, parks, golf courses, and re-siting of a village. Much of the work involves extensive tree planting with trees supplied by the NCB's forestry section. R537

## R74-51 FEDERAL AND STATE PERMITTING REQUIREMENTS

Jones, J. R. and Beckner, J. L. (Peabody Coal Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 36-53. The experience of Peabody Coal Company in obtaining permits required for the Big Sky Mine in Rosebud County, Montana, is used to illustrate how lead time required to bring a surface mine into operation has been increased by state and Federal regulations. The

R74-51 (continued)

development of mining and reclamation plans and environmental impact statements required by the National Environmental Policy Act are described. Requirements of Montana law developed by new legislation and the promulgation of regulations as Peabody was going through the permitting process are also described. The authors believe that normally about three years are needed to complete the steps necessary to obtain permits. The expenses involved are also discussed. R668

### R74-52 RECLAMATION TODAY IN PENNSYLVANIA

Jones, W. G., Coal Mining Process. 11 (6), 33-35, 58-59, 61 (1974). This study describes in detail, with pictures, reforested mined lands in Pennsylvania. The author explains his success with many species, even several which were not recommended, in a 17-county area where he has personally directed planting over 36 million trees in the past 25 years. This extensive reclamation program has also produced a large game population. R483

### R74-53 UNSUSPECTED SOURCE OF WATER POLLUTION IN SOUTHWESTERN PENNSYLVANIA

Khoury, S. G. (1) and Hipwell, R. M. (2) [(1) Dames & Moore and (2) Univ. Pittsburgh], Pa. Geol., Oct. 1974. pp 2-4. A large volume of water required for greens and tees on a golf course, built on about 60 percent stripped land, drains into another underlying coal seam which has also been mined. The water eventually emerges as acid mine drainage. It is suggested that golf courses built over shallow mines be designed with a closed drainage system that allows water recycle. R563

### R74-54 ACID STRIP MINE LAKE RECOVERY

King, D. L., Simmler, J. J., Decker, C. S., and Ogg, C. W. (Univ. Missouri), J. Water Pollut. Contr. Fed. 46 (10), 2301-2315 (1974). Clays and associated aluminum are identified as buffers in acid strip mine lakes. Also, organic material plays a necessary role in establishing conditions for sulfate reducing bacteria whose action results in evolution of hydrogen sulfide gas. The interaction between these two systems with other complex factors in the recovery of strip mine lakes is discussed. The authors suggest accelerating recovery of acid strip-mine lakes by addition of organic waste in such a way that aeration could be used to slow the rate of bacterial action if $H_2S$ were being evolved more quickly than it could be dispersed. Jour

### R74-55 BENEFITS IN COST AND EFFECTIVENESS OF LIQUID MATERIALS USE IN HYDROSEEDING OPERATIONS

Kranz, B. W. (The Valley Camp Coal Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 163-167. In this work to develop an acceptable

R74-55 (continued)

ground cover, a latex soil stabilizer, Genaqua 743, a modified vinyl acetate emulsion, gave excellent results. Evaluations of erosion control and vegetative success were made over a number of weeks on plots where Genaqua, Genaqua plus wood chips, and wood chips alone as control, were applied with a specified seed mix to three different spoil types. The latex acts as a binder to hold seed in place on compacted surface. On uncompacted surface, it holds the surface open, allowing water penetration. Liquid fertilizers were blended with the latex to give lower application costs and higher efficiency. R679

### R74-56 LAND REBORN

Ohio Board on Unreclaimed Strip Mined Lands and Ohio Dept. Natural Resour., January 1, 1974. 91 pp. This report by a team of eight consultants carries out the Board's duty under the Revised Ohio Strip Mine Law to "gather information, study and make recommendations concerning the number of acres, location, ownership, condition, environmental damage resulting from the condition, cost of acquiring and reclaiming to the standards in Section 1513.16 of the Revised Code and possible future uses and value of eroded lands within the state, including land affected by strip mining for which no cash is held in the strip mining reclamation fund." 631 037

### R74-57 AN OVERVIEW OF NEW SURFACE MINING METHODS OF STEEP SLOPES IN THE APPALACHIAN REGION

Lusk, B. E., SME Fall Meet., Acapulco, Mexico, Sept. 22-25, 1974. Preprint No. 74-F-335. 17 pp.+ In West Virginia there are now strict reclamation requirements. The resulting changes in mining methods, as well as methods of overburden handling designated as controlled placement, are described. AIME

### R74-58 SOIL RECONSTRUCTION: FOR THE BEST SOIL AFTER MINING

McCormack, D. E. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 150-162. In order to insure the highest use of land after mining, the author advocates planning the topmost layer of soil so that it will have, "from the surface downward to a depth of at least five feet, a sequence of horizons chosen from available soils and geologic strata that will provide the most favorable medium for plant growth." The soil and subsoil characteristics that will permit this topsoil reconstruction are described. The method is illustrated by its application to an area of south-central Powder River County, Montana. R678

### R74-59 FERTILIZER EFFECTS ON FORAGE CROPS ON STRIP-MINED LAND IN NORTHEAST ALABAMA

Mays, D. A. and Bengtson, G. W. (Soils and Fertilizer Res. Branch), TVA, Natl.

R74-59 (continued)

Fertilizer Develop. Cent., Bull. Y-74 (May 1974). 23 pp. This bulletin records three experiments conducted by TVA to assess the adaptability and nutrient requirements of a number of cool- and warm-season grasses and legumes for forage production on mine spoil. Detailed procedures, tabulated data, and related pictures are included for each experiment. Common Bermuda grass grew quickly in experiments 1 and 2 to prevent erosion. Experiment 3 used phosphorus on plots 1 and 2 to study the effects of phosphorus rate and time of application. Yield responses to phosphorus were very significant when fall application was made but spring applications were less effective. R485

R74-60 REVEGETATION IN THE SOUTHWEST - ITS HAZARDS AND SUCCESSES

Merkel, D. L. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc. Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 189-192. Special techniques for revegetation are needed in the Southwest because of extreme conditions such as low annual precipitation, low humidity, high soil temperatures, and high soil salinity. Criteria developed recently for seeding, planting, and mulching are discussed. Development of species adapted to the Southwest is being carried on in the Soil Conservation Service Los Lunas Plant Materials Center operated by the University of New Mexico. Sixteen varieties already developed and now being grown commercially are listed. R682

R74-61 MODERN RECLAMATION IN KENTUCKY

Office of the Governor, Ky. (undated). 4 pp. Reclamation requirements in Kentucky are discussed, and aerial and hydroseeding are described. R454

R74-62 NATIVE HARDWOODS PART OF EXPERIMENTAL SEEDING

Green Lands 4 (3), 22 (Fall 1974). A cooperative reclamation project between U.S. Steel and the U.S. Forest Service is being carried out at three test sites at Saw Pit near Gary, West Virginia. The species and amounts of native hardwoods and grass seeds were varied at each site. Jour

R74-63 NAVAJO MINE'S GOAL: TO STRIP COAL AND RECLAIM LAND AT THE SAME RATE

Mining Eng. 26 (10), 57-58 (1974). The Navajo mine of Utah International Inc. near Farmington, N. M., is the largest open pit mine in the United States. There are three seams relatively close to the surface where 35,000 tpd of coal are mined. Reclamation began in the late 1960's and spoil grading goes on three shifts a day, seven days a week. During the first year 550 acres were reclaimed and at this rate reclamation will equal the production rate by 1978. Pictures show the operation including the Four Corners generating plant which is one of the coal users. R525

### R74-64 HOW C&K COAL CO. GREW FROM A TWO-MAN START TO 23RD AMONG U.S. PRODUCERS

Martens, C. D., Coal Age 79 (9), 83-87 (1974). The development and operations, including reclamation, of the C&K Coal Co. in Clarion County, Pa., are described. Jour

### R74-65 LAND UTILIZATION AND RECLAMATION IN THE MINING INDUSTRY, 1930-71

Paone, J., Morning, J. L., and Giorgetti, L., U.S. Bur. Mines, IC 8642 (1974). 61 pp. From 1930 thru 1971 mining of all kinds has affected 3.65 million acres. About 1.46 million acres of this total, or 40 percent, have been reclaimed over the 42-year period. The reclamation rate in 1971 reached 80 percent. The major portion of reclamation has been on lands used for surface mining bituminous coal. Information on land used and reclaimed by various surface mining industries is compiled by states and also includes amounts of mineral production. BurM

### R74-66 FEASIBILITY STUDY OF A NEW SURFACE MINING METHOD 'LONGWALL STRIPPING'

Moomau, H. F., Zachar, F. R., and Leonard, J. W. (Potomac Engineering & Surveying, Petersburg, W. Va.), U.S. EPA, Environ. Protection Technol. Ser. EPA-670/2-74-002 (1974). 67 pp. Longwall stripping, which adapts existing underground longwall mining technology, was determined to be a feasible method for mining coal under shallow cover. A discussion of the criteria necessary to consider in selecting a site and developing the mining plan is included. Additionally, alternate methods of the longwall stripping concept are discussed. (Adapted from authors' abstract) R450

### R74-67 SOCIAL AND ECONOMIC IMPACTS OF POTENTIAL COAL DEVELOPMENT IN THE NORTHERN GREAT PLAINS

Osterhoudt, F. H. (Econ. Res. Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 76-87. This paper discusses the economic and social prospects of the Northern Great Plains area in the light of the anticipated development of the western coal industry, and is based on the study of the Socio-Economic and Cultural Aspects work group of the Northern Great Plains Resources Program. A sparsely populated open area, essentially agricultural, will change to a coal-industry-related community where an economic boom will affect all phases of the territory. Many of the changes such as population growth, supporting services, housing, transportation, income, employment, government policies, changes in lifestyles, and particular problems of Indian tribes are considered by the author. R671

### R74-68 SEDIMENT YIELD FROM STRIP-MINED WATERSHEDS IN EASTERN KENTUCKY

Curtis, W. R. (Northeastern Forest Expt. Sta., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 88-100. Erosion rates and sediment yields from surface-mined areas in eastern Kentucky watersheds were determined by studies of three settling basins built on mined and unmined areas in Breathitt County. Data on sedimentation, watershed size, disturbed acreages, dates of mining, and precipitation were used to develop sediment-basin specifications and requirements. Results showed highest sediment yield during the first six months after mining. Erosion rates decreased to fairly low levels within three years. Revegetation is given as the most effective sediment-control measure when done in minimum time following mining. Also, an area mined using a number of "head of the hollow" fills and ridge-top removal showed reduced sediment yield. R672

### R74-69 PAVED HAUL ROAD, 10-WHEEL TRUCKS BOOST OUTPUT OF WEST VIRGINIA FIRM

Coal Age 79 (6), 94-95 (1974). Perry and Hylton, Inc. is creating thousands of acres of broad plateau suitable for residential, commercial and institutional use. The company is using overburden to fill worked out areas, pits and valleys. Vegetation is removed first and topsoil is saved. Next an earthen dam is built at the widest point to provide a base for the work and prevent water runoff. Replanting is done using fertilizer and topsoil with lime to neutralize acidity. Asphalt haul roads have been installed and a savings of 50 percent is estimated in road maintenance. Jour

### R74-70 GROUND WATER QUALITY AT A STRIP-MINE RECLAMATION AREA IN WEST CENTRAL ILLINOIS

Pietz, R. I., Peterson, J. R., and Lue-Hing, C. (Metropolitan San. Dist. Greater Chicago), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 124-144. Twenty-four groundwater monitoring wells were established both on non-disturbed and on strip-mined land in Fulton County, Illinois, to provide baseline environmental data for twenty-three chemical characteristics. These lands are being reclaimed to agriculture by applications of digested sewage sludge from Metropolitan Sanitary District of Greater Chicago. Water samples were analyzed monthly from December, 1971 to December, 1973. Data show that mine spoil groundwaters have higher metal contents as well as greater concentrations of chlorine, sulfate, and Kjeldahl nitrogen. Also groundwaters of the mined areas have a greater number of significant monthly, seasonal and well-to-well variations in the chemical constituents analyzed for. Data from a typical mined area monitoring well were used to explore the possibility of using the monitoring data for evaluation of future groundwater quality. R676

R74-71 REVEGETATION PROJECTS DOMINATE SURFACE-MINE RESEARCH

Plass, W. T. (Northeastern Forest Expt. Sta., Princeton, W. Va.), Coal Mining Process. 11 (8), 40-41, 50 (1974). Experimental work has shown that West Virginia spoil material is particularly deficient in nitrogen and phosphorus. Pictures show the test-work results and also the results of direct seeding of grasses and tree species. The acreage of land reclaimed has increased measurably in the recent years. R530.

R74-72 REVEGETATING SURFACE-MINED LAND

Plass, W. T. (Northeastern Forest Expt. Sta., USDA), Mining Congr. J. 60 (4), 53-59 (1974). There are several factors in revegetating surface-mined land. Site evaluation includes physical characteristics, chemical variation of overburden, and spoil-classification systems. Site preparation includes reshaping of the surface as well as the use of fertilizers and other soil amendments. Revegetation techniques include both species selection and planting method. R451

R74-73 PHYSICAL AND CHEMICAL CHARACTERISTICS OF SURFACE MINE SPOIL TREATED WITH FLY ASH

Plass, W. T. and Capp, J. P., J. Soil Water Conserv. 29 (3), 119-121 (1974). This article describes the use of 150 tons/acre of fly ash to neutralize extremely acid surface-mine spoil. Three plots were used for test purposes. Analytical work showed the fly ash not only neutralized acid but it also added minerals and nutrients to the mine spoil. Tabulated data give moisture and chemical content of the treated area. Phosphorus content of the treated plot was almost three times as high as on the untreated plot. Infiltration rates were increased with fly ash and a lower density near the surface was credited as the reason for this characteristic. Increased moisture contents in treated area were significant. R490

R74-74 PREPLANNING: SURFACE MINING FOR OUTDOOR RECREATION

U.S. Dept. Int., Bur. Outdoor Recreation, 1974. 22 pp. This booklet was printed following a meeting held in 1973 on the subject of reclamation directed at emphasizing outdoor recreation development. A specific example is the development of Friendship Park in Jefferson County, Ohio, into an 1100-acre year-round recreation complex. The public, industrial and economic factors, the recreational use of surface-mined land, and the value of preplanning for such a project are discussed. R541

R74-75 PROFITABLE FARMING IS THE GOAL AT MEADOWLARK

Coal Age 79 (10), 135-138 (1974). Meadowlark Farms, a subsidiary of Amax Coal Co., grows crops, raises livestock, harvests timber, and rents pastureland acreage overlying Amax coal reserves or on reclaimed land recently strip

R74-75 (continued)

mined. The company arranges leases with farmers who operate the particular farms. More than 3 million dollars worth of land rehabilitation equipment is in continuous use, and at present 150 tenants hold crop or livestock share leases. This arrangement allows the farmer to live on his own property. Jour

## R74-76 PROPOSED PLAN OF MINING AND RECLAMATION, BIG SKY MINE, PEABODY COAL COMPANY LEASE M-15965, COLSTRIP, MONTANA

Geol. Surv., U.S. Dept. Int., March 7, 1974. Vol. 1, 438 pp; Vol. 2, (352 pp). These two volumes of the final environmental impact statement include the draft statement with amendments and corrections, the transcript of the hearing, comment from interested groups and individuals, and responses to pertinent comments. 631 U34

## R74-77 SURFACE MINING TECHNOLOGY IN THE UNITED STATES

Ramani, R. V. (1), Stefanko, R. (1), and Ferko, M. R. (2) [(1) The Pa. State Univ. (2) Pa. Dept. Environ. Resour.], Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 204-216. Different size shovels and draglines were studied to gather performance data over several months' operating period. Records kept included available hours, downtime, mechanical hours, percent time worked and yardage handled. One conclusion is the need for training of surface-mine personnel since machinery effectiveness was shown to be related to the skill of the operator. Also the selection of large equipment was questioned since the larger dragline had excessive downtime from mechanical failures. A number of sketches and diagrams illustrate several material handling techniques and mining methods. Plan views are also included for several strip-mining operations. R684

## R74-78 RECLAIMING MINED LANDS

Chem. Eng. 81 (26), 70, 72 (1974). Surface mining and reclamation in the United States and some state regulations passed recently are reviewed. R548

## R74-79 RECLAMATION FACTORS TO KEEP IN MIND WHEN PLANNING A SURFACE MINE OPERATION

Coal Age 79 (11), 87 (1974). Preplanning for reclamation as cited by Frank W. Glover, Jr., assistant state resource conservationist, U.S. Dept. Agriculture, Soil Conservation Service," involves locating access roads, deciding on major waterways, choosing the measures to control sediment, determining proper spoil placement...and establishing vegetation on all disturbed areas as soon as possible." Preplans are the responsibility of the particular operator but the Conservation Service will supply help if requested. Jour

R74-80 STRIP MINING IN CAPE BRETON

Reid, J. S. (Cape Breton Dev. Corp., Coal Div.), Can. Mining Met. Bull. 67 (752), 75-79 (1974). The mining operation at the Alder Point Strip Mine is described. Fifteen species of evergreen trees are being tested for reclamation. Jour

R74-81 SURFACE MINING - AN INTERIM LAND USE

Reiss, I. H. (Meadowlark Farms, Inc.), AIME Ann. Meet., Dallas, Tex., Feb. 23-28, 1974. Preprint No. 74-F-22. 5 pp. In describing the Meadowlark Farms operation in strip-mine reclamation, the author emphasizes that they have reclaimed all territory they mined and have been doing so since 1945. To put strip mining in perspective, the author noted that in the United States, strip mining has involved 6 million acres of a total of 2300 million or one-fourth of one percent of our total area. R476

R74-82 SURFACE MINING - AN INTERIM LAND USE

Reiss, I. H. (Amax Coal Co.), Am. Mining Congr. Convention/Exposition, Las Vegas, Nev., Oct. 7-10, 1974. 17 pp. The Meadowlark Farms operation, active since 1945, is described. 662.6 A665

R74-83 WE ARE FARMERS NOT MINERS

Reiss, I. H., Coal Mining Process. 11 (5), 50-51, 63 (1974). Meadowlark Farms, the land management subsidiary of Amax Coal Co., has set up operating leases with 129 local farmers who work the land on an incentive basis. Currently the company has over 2000 head of cattle. In 1973 alone they produced over 1 million bushels of grain and sold over 1 million pounds of cattle and hogs. In recreational facilities the company has created over 1000 acres of water for use by the public for fishing, swimming, and boating. R460

R74-84 REMOTE SENSING OF COAL MINE POLLUTION IN THE UPPER POTOMAC RIVER BASIN

Ambionics, Inc., Final Rept., Contract No. NAS-1-12673 (undated). 66 pp. NTIS, N74-34817. Conclusions from the study are that the combined approach of ERTS imagery, corresponding aircraft photography, and ground study are needed for an effective program of continuous mine-acid pollution monitoring; and that methods of detecting mine-acid polluted water from aircraft imagery, and methods of monitoring strip-mine activity from ERTS imagery have been developed. 74-76

R74-85 ECOLOGY--ALLY OF MINED LAND RECLAMATION

Riley, C. V. (Kent State Univ.), Natl. Coal Assoc./Bitum. Coal Res., Inc.,

R74-85 (continued)

Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 54-68. Since much of the land being strip mined for coal is suitable for grazing, wildlife, forestry, and recreation, the author contends that it can be restored at lower cost by enhancing naturally developing ecosystems through mining and reclamation techniques that achieve the basic goals of stabilizing the reclaimed land against erosion or landslides, preventing mine drainage, and encouraging revegetation. Strip-mined areas and a strip-mine lake in Ohio are described to illustrate how natural processes over a period of about 15 years have restored the land so that it supports vegetation and animal populations and have improved the water so that it supports fish and other aquatic life. R669

### R74-86 MINING AND RECLAMATION IN KENTUCKY

Roberts, J. R. (Ky. Dept. Natural Resour. Environ. Protect., Div. Reclamation), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 1-4. The development of Kentucky's reclamation laws and regulations is reviewed. Presently the Reclamation Division of the Department for Natural Resources and Environmental Protection monitors quality of drainage from surface mining; oversees the reclamation of surface disturbed by underground mining as well as by all surface mining; and has cooperative research programs with EPA and the Appalachian Regional Commission. R662

### R74-87 REVEGETATION POTENTIAL OF WESTERN RANGELANDS IN THE OIL SHALE REGION

Sedgley, E. F. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 29-33. The various types of vegetation in different parts of the area are described and are related to the elevation of the land. However, present vegetation may not represent the natural vegetative pattern since other factors such as grazing and man's protection from natural fires may have altered it. The research needs identified will take many years to complete but present knowledge can be put to immediate use. Also, demonstration plots indicate that spent shale will support a variety of plants with proper leaching, mulching, fertilizing, and irrigation. R666

### R74-88 MINE SPOIL POTENTIALS FOR SOIL AND WATER QUALITY

Smith, R. M., Grube, W. E., Jr., Arkle, T., Jr., and Sobek, A. (W. Va. Univ., College Agr. Forestry, Div. Plant Sci.), U.S. EPA, Environ. Protection Technol. Series EPA-670/2-74-070 (Oct. 1974). 302 pp. The purpose of this detailed study of coal overburden and coal-related strata is to enable coal strip miners to plan the overburden placement in reclamation so that acid runoff is reduced and the most favorable soils are available for plant growth. Specific suggestions are made for dealing with overburden associated with

R74-88 (continued)

particular coal seams. The results of the extensive overburden sampling and testing program in West Virginia are tabulated, and the step-by-step analytical procedures used are presented so that they can be followed by others carrying out similar studies on lands to be mined. 74-25

R74-89 OVERBURDEN PROPERTIES AND YOUNG SOILS IN MINED LANDS

Grube, W. E., Jr., Smith, R. M., Sencindiver, J. C., and Sobek, A. A. (W. Va. Univ.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 145-149. Analysis of overburden will show which layers are toxic and should be buried, which have favorable levels of minerals for plant growth and should be used as surface, and if weathering of particular layers will be advantageous to the planned use of the land. Overburden analysis as part of reclamation plans also allows such specific decisions as use of clayey materials as the base of water impoundments to reduce seepage and use of neutralizing layers to help counteract acid toxicity. Although a disadvantage of young soils is lack of organic matter, it can be reclaimed from the original surface and incorporated into the new soil. New soils also have the advantage of allowing vegetation to develop a deep root structure. Amounts of extractable plant nutrients at eight specific areas in West Virginia, Kentucky, Indiana, and Illinois are tabulated. R677

R74-90 USING SEWAGE EFFLUENT AND LIQUID DIGESTED SLUDGE TO ESTABLISH GRASSES AND LEGUMES ON BITUMINOUS STRIP MINE SPOILS

Sopper, W. E., Kardos, L. T., and Edgerton, B. R., The Pennsylvania State University, Institute for Research on Land and Water Resources, Final Research Project Technical Completion Report to U.S. Department of the Interior, Office of Water Resources Research, Project B-047-PA, March 1974. 153 pp. NTIS, PB-232 069. The effects of irrigation with municipal sewage effluent and liquid digested sludge on strip-mine spoils were studied by filling 6 large lysimeters with strip-mine spoil material and seeding them with 8 grass and 8 legume species. The samples were treated with sewage effluent and liquid digested sludge. The spoil was irrigated weekly during the period May 24 to Sept. 21, 1972. The grasses did much better than the legumes. The results indicated that treated municipal sewage effluent and liquid digested sludge are valuable means of amending harsh conditions which make spoil banks unsuitable for growth of vegetation. R517

R74-91 SOURCES OF ASSISTANCE IN RECLAIMING SURFACE-MINED LANDS FOR OUTDOOR RECREATION

U.S. Dept. Int., Bur. Outdoor Recreation, Bur. Mines (undated). 72 pp. GPO SN 2416-00061. This booklet lists 27 governmental and private agencies which will provide information on reclaiming land. The functions of these agencies are described and a number of references are included with the agency writeup.

R74-91 (continued)

A summary of all state mined-land regulations is given itemized by states. Also included is a list of mined-land reclamation demonstration projects, their cost and status. R229

R74-92 CONFERENCE ON RESEARCH AND DEVELOPMENT NEEDS FOR SURFACE COAL MINING

Stefanko, R. and Ramani, R. V., by Pa. State Univ. and U.S. Bur. Mines, St. Clairsville, Ohio, July 26, 1974. 9 pp.+ The publication records the meeting held to informally discuss surface mining related problems and to obtain recommendations from the participants on the most feasible approach to these problems. An agenda is included as well as comments by Mr. Stefanko on the purpose of the conference. Results of the discussions will be forwarded to the USBM in the hope that they will consider funding work in line with the industry recommendations. Legislative restrictions were criticized as being too tight in many instances. R524

R74-93 SURFACE MINE WATER QUALITY CONTROL IN THE EASTERN KENTUCKY COAL FIELDS

L. Robert Kimball, Consulting Engineers, Rept. to Ky. Dept. Natural Resour. Environ. Protection and Appalachian Regional Comm., ARC-71-66-T5 (March 1974). 92 pp.+ This report is concerned with acid surface mine drainage and other forms of chemical water pollution attributed to surface mining in the Eastern Kentucky Coal Field and gives primary emphasis to identifying coal seams with the highest acid producing potential. The parameters, criteria, and methodology developed and used to achieve this end are described. The research effort included a general evaluation of existing water quality data for all the major drainage basins in the Eastern Kentucky Coal Field, followed by a concentrated study in the Kentucky, Big Sandy, and Cumberland River Basins. (Adapted from Summary) 631 K37

R74-94 SURFACE MINING...A CHANGING INDUSTRY

W. Va. Surface Mining Reclamation Assoc., Special Publ., (undated, issued 1974). 48 pp. This booklet shows the many new methods of mining and reclamation recently developed. Longwall stripping is diagrammed in detail and discussed. Special mention is given to material handling on steep slopes and methods which produce maximum coal recovery. The issue emphasizes the need for surface mining and the advantageous methods which make it economically feasible in West Virginia. R492

R74-95 THE SURFACE MINING OF COAL

Energy Perspectives, Battelle Memorial Inst., No. 8, March, 1974. pp 1-5. This short information bulletin discusses various phases of surface mining and the problems of reclamation. A series of pictures shows the results of

R74-95 (continued)

subsidence, spoil banks which have not been reclaimed, and a number of revegetated areas. Illustrations of German lignite strip mining are included and final results show sugar beets growing on the restored land. It is now possible to remove economically 160 feet of overburden to recover a 4-foot seam of coal. R486

### R74-96 HYDROLOGIC STUDY OF A RECLAIMED SURFACE MINED AREA ON THE BLACK MESA

Thames, J. L., Patten, R. T., and Crompton, E. J. (Univ. Ariz.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 106-116. Two 5-acre watersheds, 3/4 mile apart, one on recontoured mined land and one on undisturbed land, were monitored in this study of water availability and quality in the arid southwest. There was no runoff from rain in the study time reported. However, from about the same amount of snowfall there was much greater runoff from the undisturbed area than from the mined area. Water quality analyses showed that while runoff water from the mined area had a higher content of salts than runoff from the unmined area, it was somewhat similar to local municipal water supplies and had lower salt content than water used for irrigating cropland and orange groves in the region. R674

### R74-97 THIRTY MEMBER COMPANIES ATTEND TOUR OF 'PENNSYLVANIA BOXCUT'

Green Lands 4 (1), 27 (1974). The boxcut method and reclamation required with it in Pennsylvania are pictured. There is a critique of the method from the point of view of West Virginia experience and regrading requirements. Jour

### R74-98 BREEDING VIRGINIA PINE FOR BETTER GROWTH ON ACID SPOIL

Thor, E. (1), Rink, G. (1), and Plass, W. T. (2) [(1) Univ. Tenn. and (2) Forest Serv., USDA], Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 168-174. This study was done to evaluate the variation in growth rate in an open-pollinated progeny test plantation on a strongly acid strip-mine spoil. Site differences, phenotypic variation, and genetic variability cause growth rate differences. Tree heights were measured after one, two, and five growing seasons. Soil samples were also analyzed. Preliminary analysis indicates that from one-quarter to one-third of the total variation in height may be accounted for by spoil characteristics. R680

### R74-99 SURFACE MINE RECLAMATION IN MONTANA

Thornburg, A. A. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 18-21. Criteria used in planning reclamation in Montana are discussed. Work is being carried out to make native

R74-99 (continued)

grasses available for revegetation, since over 95 percent of the land to be surface mined is native rangeland, which will probably be returned to the same use. R664

### R74-100 TO HEAL THE SCARS

Forest Service, U.S. Dept. Agr., NE-INF-18-74 (undated). This information booklet contains a general discussion of surface mining and the problems of reclamation, particularly revegetation, water quality, and sedimentation. R597

### R74-101 STRIP MINE RECLAMATION IN WYOMING

Tresler, R. L. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 22-28. Reclamation in the coal area of southwestern and south central Wyoming, the uranium area of Shirley Basin and the Gas Hills, the bentonite area of the Big Horn Basin, the Black Hills bentonite area, and the Powder River Basin is described in detail. Mining and reclamation of the Kemmerer Coal Company are used as an example in the southwestern and south central region, and the activities of Pacific Power & Light Co., Amax Coal Co. and Big Horn Coal Co. in the Powder River area. The contribution of the Soil Conservation Service has been in preparing soil maps showing soil characteristics and suitability and in developing planting methods and plant materials. A revegetative technique also being tried is transferring shrubs and associated soil from areas to be mined into an area to be reclaimed. R665

### R74-102 THE TRIUMPH OF SURVIVAL

The Pipeliner, Dec. 1974. 2 pp. The reclamation research supported by El Paso and Western Coal Co. and conducted by the Agricultural Experiment Station of New Mexico State Univ. is described. Various species of grasses are being tested in plots on a mined area near El Paso's Navajo coal lease. R562

### R74-103 U.S. MINING INDUSTRY RECLAIMS 80% OF SURFACE ACREAGE USED IN 1971

Mining Eng. 26 (10), 59-60 (1974). The information presented in U.S. Bureau of Mines IC 8642, "Land utilization and reclamation in the mining industry, 1930-71" is discussed. See R74-65. R526

### R74-104 HYDROLOGIC EFFECTS OF STRIP COAL MINING IN SOUTHEASTERN MONTANA - EMPHASIS: ONE YEAR OF MINING NEAR DECKER

Van Voast, W. A., Montana Bur. Mines Geol., Bull. 93, June, 1974. 24 pp.

R74-104 (continued)

This publication describes the hydrologic effects of strip mining done by the Decker Coal Co. in southeastern Montana. The total water movement into and out of the mine is about 400,000 gals/day. The area depends on this water source for stock and domestic uses. It is expected as mining and reclamation proceed that the water flow will decrease through the area. If the mining cut is completely filled, maximum water-level recoveries will result but minimum recoveries will occur if the cut is left completely unfilled. Extensive flow rate and chemical data are included. Several maps give the details of the watershed area. R533

### R74-105 ALL SEASON SEEDING OF HERBACEOUS VEGETATION FOR COVER ON APPALACHIAN STRIP-MINE SPOILS

Vogel, W. G. (Northeastern Forest Expt. Sta.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 175-186. To learn whether strip mine spoils could be successfully seeded at times other than spring and fall, mixtures of permanent and temporary species were sown at twelve different times throughout the year on spoils in Eastern Kentucky. Although the best seeding times were found to be early spring and late summer to early fall, late spring and early to mid-summer seedings were also successful. Seedings after November 1 normally will not germinate until after the following March 1, but areas made ready for seeding in winter should be mulched to reduce erosion. Temporary species develop more quickly than permanent species and can provide erosion control and protect the young permanent plants. However, if the temporary species are too dense they can retard development of the permanent vegetation. Some sort of seedbed preparation contributes to success of planting whether it is use of freshly graded spoils, rototilling previously graded spoils, or the natural seedbed preparation of freezing and thawing of late winter weather. R681

### R74-106 FINITE ELEMENTS AND STRIP MINING EQUIPMENT

Wheeler, O. E. (Bucyrus-Erie Co.), AIME Ann. Meet., Dallas, Tex., Feb. 23-28, 1974. Preprint No. 74-F-51. 18 pp. This paper describes the use of "finite element analysis" in the design of earth-moving equipment. This procedure consists of using imaginary simple structural elements to construct analytical models of real structures. The practice was developed by engineers having to solve complex structural problems. This technology is incorporated into the design process which makes possible predictions of structural response. This program was adapted by the Bucyrus-Erie Co. to building heavy earth-moving equipment. R477

### R74-107 SEDIMENT CONTROL USING MODIFIED MINING AND REGRADING SYSTEMS AND SEDIMENT CONTROL STRUCTURES

White, J. R. (1) and Plass, W. T. (2) [(1) Pioneer Fuel Co. and (2) Forest

R74-107 (continued)

Serv., USDA], Natl. Coal Assoc./Bitum. Coal Res., Inc., Second Res. Applied Technol. Symp. Mined-Land Reclamation Preprints, Louisville, Ky. (1974). pp 117-123. The sediment control program described is near Beckley, West Virginia on an area of 400 acres where three coal seams were mined. The control system consisted of three impoundments and the details of their construction are given. Head-of-the-hollow fills, designed and built to help control drainage, each contained a French drain. Regrading and revegetation were carried on during mining. Stream flow measurements and sediment records made during the 21-month observation showed that the control system was effective in trapping storm runoff and preventing coarse size fragments and sediment from entering streams. R675

## R74-108 ERTS MONITORING OF SURFACE MINING OPERATIONS

Wobber, F. J. and Martin, K. R., World Mining 27 (3), 56-57 (1974). Images of an area in Belmont County, Ohio, taken by high-altitude aircraft and by satellite, are used to illustrate the ability of remote sensing techniques to monitor mining and reclamation. R602

## R74-109 RECLAMATION OF TOXIC SPOIL STACK FOR VARIOUS SELECTED SOIL CONDITIONS - WITH THE TUROW LIGNITE MINE AS AN EXAMPLE

Bauman, K., Main Research and Design Institute for Opencast Mining (POLTEGOR), Wrocław, Poland, 2nd Interim Report Dec. 1, 1973 - Oct. 31, 1974 to U.S. Environmental Protection Agency, Special Foreign Currency Program, Project No. 05 - 532 - 11, Nov. 1974. 99 pp.+ Experiments in establishing vegetation at two surface mines in Poland are described in detail. Amendments to neutralize acid spoil and to fertilize spoils were added to plots at both sites in a variety of combinations, amounts, and incorporated into the spoil by several techniques. There are tabulations of production of vegetation and results of analyses for Na, K, Ca, Mg, P, N, S, C, C/N, Zn, Cu, Mn, Fe, and Al of grasses and legumes planted at the Turow mine. Trees planted at the Turow mine were observed after one year and their growth was recorded. Both greenhouse and field tests of grasses and legumes were carried out at the Przyjazn Narodow mine. Results at both sites indicated that revegetation was most successful with lime and ground phosphorus rock deeply incorporated into the spoil. Also included in the report are spoil characteristics and analyses, and precipitation, air pollution ($SO_2$), and water quality data. R904

## R74-110 REVEGETATION GUIDELINES FOR SURFACE MINED AREAS

Cook, C. W., Hyde, R. M., and Sims, P. L., Colorado State University, Range Science Department, Science Series No. 16 (Dec. 1974). 73 pp. The guidelines presented are recommendations from studies carried on by the authors and from studies reviewed by the authors that deal with the rehabilitation of various vegetation types throughout the areas of the West that are underlain with either coal, oil shale, or uranium. The studies were concerned with

R74-110 (continued)

with methods and techniques of establishing vegetation on disturbed lands that involved the use of mulches, fertilizer, chemicals for weed control, the testing of adapted species, and methods of planting. (From authors' Introduction) R1014

## R74-111 DESIGN OF SURFACE MINING SYSTEMS IN EASTERN KENTUCKY: RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES IN EASTERN KENTUCKY

Mathematica, Inc. and Ford, Bacon & Davis, Inc., Engineers, Report to Kentucky Department for Natural Resources and Environmental Protection and the Appalachian Regional Commission, ARC-71-66-T1 (Jan. 29, 1974). Volume II (395 pp.) Volume III, Appendixes A-H (248 pp.) The evolution of existing methods for surface mining of coal in mountainous terrain is discussed. Existing methods--categorized as contour and area (on mountaintops) methods--are described. Frequency of use of each method in 1972 is estimated. Also discussed are practical advantages and limitations of several of the methods, based on actual field observations and discussions with mine operators and regulatory personnel. Differences between theory and practice are noted. The appendices contain the basic production data and descriptions of the methodologies used during the course of the study. They have been included to make available for further or different kinds of analysis, the "raw data" that underlies many of the statistics quoted in Volumes I and II of this report; to illustrate concretely the kinds of things that can and should be done with the aid of computers; and to make available summary statements of the methodologies and assumptions used during the study. (From abstracts of Vol. II and Vol. III) R850, R851 (See R74-30 for abstract of Volume I)

## R74-112 CONOTTON CREEK SUBWATERSHED ANALYSIS

DiGennaro, A. A., Secor, E. S., and Leeson, D. E., Ohio Department of Natural Resources, Mined Lands Restoration Unit, Mined Land Reclamation Program Report #1, prepared in cooperation with Carroll County Regional Planning Commission and Tuscarawas County Regional Planning Commission (Dec. 1974). 116 pp. Available from Ohio Dept. Natural Resources, Mined Lands Restoration Unit, Division of Planning, Fountain Square, Building "E" Columbus, Ohio 43224. This report represents an initial attempt to develop an analysis procedure for the reclamation of mined land within Ohio. It includes descriptions of the process used to select the study area in Carroll and Tuscarawas Counties, the computerized mapping program, the process of capability analysis and its application to mined land, and the manual site analysis used in this report. Appendix One contains the detailed soil survey conducted by the Division of Lands and Soil. Appendix Two illustrates the planning and strategy process recommended by the Board on Unreclaimed Strip Mined Lands in its report, "Land Reborn." (Adapted from authors' Summary) R1021

### R74-113 THE RECLAMATION OF LAND AFTER COAL MINING

Doubleday, G. P. (Durham County Council, England), Outlook on Agriculture 8 (3), 156-162 (1974). This discussion of reclamation of mined lands compares practices and governmental regulations in Great Britain, Germany, and the United States. Reclamation of coal refuse piles or "tips" is also considered. R1017

### R74-114 REVEGETATION RESEARCH ON THE DECKER COAL MINE IN SOUTHEASTERN MONTANA

Farmer, E. E., Brown, R. W., Richardson, B. Z., and Packer, P. E., U.S. Dept. Agr., Intermountain Forest and Range Experiment Station, Forest Service Research Paper INT-162 (1974). 12 pp. First-year results of revegetation research at the Decker coal mine in southeastern Montana are described. Three types of main plots were located on overburden material: (1) a control plot, (2) an irrigated plot, and (3) a plot dressed with topsoil materials. Each main plot consists of 48 subplots for a total of 144 subplots. Treatments included different grass mixtures, fertilizer, and mulch on irrigated and unirrigated plots. On the basis of dry-weight grass production, several treatments produced acceptable first-year grass stands. The top-dressing of mine overburden appears to be a highly desirable revegetation practice. Generally, wheatgrasses (*Agropyron* spp.) have dominated the dry-weight production. (Authors' abstract) R757

### R74-115 RESPONSES OF *LOLIUM PERENNE* AND *AGROSTIS TENUIS* TO PHOSPHATE AND OTHER NUTRITIONAL FACTORS IN THE RECLAMATION OF COLLIERY SHALE

Fitter, A. H. and Bradshaw, A. D. (University of Liverpool), J. Applied Ecol. 11 (2), 597-608 (1974). In field and greenhouse studies made on South Lancashire coal mine spoils (colliery shale), there was vegetative response to the addition of nitrogen only on less acid spoils, and phosphorus was found to be deficient in all spoils. Analyses of shales and of plants grown on them show that both bicarbonate-soluble phosphorus and the buffering capacity of phosphorus must be measured to determine accurately the amount of phosphorus amendment needed to support plant growth on coal mine spoils. CE343

### R74-116 CHEMICAL FACTORS CONTROLLING THE ADAPTATION OF WEEPING LOVEGRASS AND TALL FESCUE TO ACID MINE SPOILS

Fleming, A. L., Schwartz, J. W., and Foy, C. D. (U.S. Department of Agriculture, Plant Physiology Institute, Beltsville, Maryland), Agronomy J. 66 (6), 715-719 (Nov.-Dec. 1974). These two species were grown for 26 to 31 days in nutrient solution with pH, Al, Mn, and P as variables. Both species withstood pH 4-5 and excess Mn (4-64 ppm). Weeping lovegrass was more tolerant to Al in the range of 2-12 ppm. P promoted the growths of both species without Al and in higher concentration (6 ppm) somewhat decreased the effects of Al on tall fescue. R1010

## R74-117 IMPACT OF HIGHER ECOLOGICAL COSTS ON SURFACE MINING

Foreman, W. E., Virginia Polytechnic Institute and State University, report to U.S. Bureau of Mines, Office of Assistant Director--Mineral Supply, BuMines OFR 12-75, June 1974. 170 pp. NTIS, PB-240 441. A mathematical model was developed to assess the costs for reclamation of surface mining using the shovel overcasting operation, the front end loader operation, and a backfilling operation. A literature review was made of the present laws in Kentucky, Pennsylvania, Virginia, and West Virginia pertaining to surface mining and of the various parameters that influence the input data for a mathematical model. It was determined that the working mathematical model would have to be applied on an area to area basis, preferably on a permit by permit basis in the area where surface mining was being done. To this end, a flexible model was was developed with input data obtained from the area of study. The results of the study show that the cost per ton of coal for reclamation can be estimated for various reclamation levels. Validation of the model was done for selected permits from Virginia. It was determined that the permits could easily be used for input data to the model. (Author's abstract). R778

## R74-118 SURFACE MINING AND MINED LAND RECLAMATION: A SELECTED BIBLIOGRAPHY

Honkala, R. A., The Old West Regional Commission, 1730 K Street, N.W., Suite 426, Washington, D.C. 20006, Oct. 1974. 154 pp. The 1337 citations are not annotated but are divided into a number of subject categories. The Name Index includes authors of the publications. R779

## R74-119 NATURAL VEGETATION AND ENVIRONMENTAL ASPECTS OF STRIP MINED LAND IN THE LIGNITE COAL FIELDS OF SOUTHEASTERN SASKATCHEWAN

Jonescu, M. E., Ph.D. Thesis, University of Saskatchewan, 1974. 234 pp. University Microfilms, 76-10,551. Vegetation and overburden material were studied in a chronosequence of ridges, 0-40 years old. Per cent cover on four aspects of ridge slopes, and species presence in three moisture levels (wet, medium, dry) in interridge areas and on adjacent prairie were measured. North and east aspects of ridge slopes were more favourable for vegetation than were south and west. No significant differences with time were found in vegetation on the ridges, implying that conditions are unfavorable to development of vegetation beyond pioneer stages. Substrate material varied considerably in gravimetric wetness, texture, and chemical composition. Sodium levels were generally high; available nitrogen and phosphorus were very low. Diversity and dominance analyses of interridge vegetation demonstrated changes significantly related to time and were interpreted to be evidence of a chronosequence of successional stages. Mesic sites appeared to be more favourable than either xeric or hydric for development of increasing amounts and diversity of vegetation. Although no significant change in vegetation has occurred on the ridges during 40 years, the interridge areas have provided a habitable environment for native prairie species. Recommendations concerning use of older stripped areas, and procedures for making decisions about the future of the area, are given. (From author's abstract) 631 J76

## R74-120 IMPLEMENTING THE CHICAGO PRAIRIE PLAN

Kudrna, F. and Kelly, G. (The Metropolitan Sanitary District of Greater Chicago), in "Conference on Recycling Treated Municipal Wastewater Through Forest and Cropland," W. E. Sopper and L. T. Kardos, Eds., U.S. EPA, Office of Research and Development, Washington, D.C., Environmental Protection Technology Series EPA-660/2-74-003 (March 1974). pp 342-347. The disposal of sewage sludge on surface-mine land in Fulton County, Illinois, is described. CE183

## R74-121 RESTORATION OF ACID SPOIL BANKS WITH TREATED SEWAGE SLUDGE

Lejcher, T. R. and Kunkle, S. H. (U.S. Forest Service, Shawnee National Forest), in "Conference on Recycling Treated Municipal Wastewater Through Forest and Cropland," W. E. Sopper and L. T. Kardos, Eds., U.S. EPA, Office of Research and Development, Washington, D.C., Environmental Protection Technology Series EPA-660/2-74-003 (March 1974). pp 165-178. Sewage sludge from the Metropolitan Sanitary District of Greater Chicago was applied to test plots at a surface-mine site in southern Illinois known as the Palzo Tract. The heaviest treatment (304 metric tons per hectare) produced the most vegetative cover and also reduced acidity, iron, and aluminum in the runoff from the treated area. Plans for expanding the treatment over the entire Tract are proposed. A tabulation shows the impact of the untreated runoff on the receiving stream, Sugar Creek. Monitoring to be carried out under the proposed plan will show whether or not land disposal of sewage sludge can improve the quality of mine runoff. CE182

## R74-122 REHABILITATION POTENTIALS AND LIMITATIONS OF SURFACE-MINED LAND IN THE NORTHERN GREAT PLAINS

Packer, P. E., U.S. Department of Agriculture, Intermountain Forest and Range Experiment Station, Forest Service General Technical Report INT-14 (July 1974). 44 pp. Northern Great Plains Resources Program Report No. NGPRP/CD-74/403. NTIS, PB-244 846. The amounts and distribution of precipitation, soil productivity and stability, and suitability and availability of native vegetation for revegetation are analyzed for each surface-minable coal-bearing area in a region which includes portions of North Dakota, Montana, and Wyoming, and the revegetation potential for each area is rated. Also discussed are existing revegetation efforts on all of the mines in the Northern Great Plains, the cost of revegetation, and the legal basis for enforcement of surface-mine rehabilitation regulations. (Adapted from author's abstract) R1016

## R74-123 FACTORS AFFECTING THE ESTABLISHMENT OF DIRECT-SEEDED PINE ON SURFACE-MINE SPOILS

Plass, W. T., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service Research Paper NE-290 (1974). 5 pp. In a greenhouse study the emergence, survival, and growth of seven species of pine were related to chemical and textural characteristics of 12 Kentucky spoils. The

R74-123 (continued)

results identify three factors that may affect the establishment of direct-seeded pine on surface-mine spoils. First, fine-textured spoil material may restrict seedling emergence. Second, species vary in their response to chemical and physical characteristics of the spoil material. Finally, the growth of lob-lolly pine was greater where the percentage of phosphorus in the whole plant was greatest. (Author's abstract) R839

R74-124 SHALLOW-COVER COAL: NEW MINING METHODS AND THE ENVIRONMENT

Reavis, J. L., Jr., The University of Kansas, Institute for Mineral Resource Research, Final Report for The Ozarks Regional Commission, Contract No. TA 73-9 (N), Sept. 1, 1974. 87 pp. The report discusses the application of auger mining and longwall mining to surface mining for coal. The costs of using each method are estimated. R962

R74-125 STRIP-MINE REGULATION AND RECLAMATION: AN ATTITUDE SURVEY

Reddy, N. N. and Buehler, C. J., Arizona Review 23 (3), 1-4 (1974). This small survey was conducted by mail in parts of West Virginia, Pennsylvania, and New York to determine the perception of strip mining as a problem, whether banning strip mining was favored, and the respondents' willingness to pay some of the cost of reclamation. R805

R74-126 REHABILITATION POTENTIAL OF WESTERN COAL LANDS

A Report to the Energy Policy Project of the Ford Foundation by Study Committee on the Potential for Rehabilitating Lands Surface Mined for Coal in the Western United States, Environmental Studies Board, National Academy of Sciences and National Academy of Engineering, Cambridge, Massachusetts: Ballinger Publishing Company, 1974. 198 pp. The area covered by this report contains the Northern Great Plains Coal Province of Montana, North Dakota, South Dakota, and Wyoming; the Rocky Mountain Coal Province of Arizona, Colorado, New Mexico, and Utah; and the Pacific Coast Coal Province in the State of Washington. The report considers "Water Resources in Relation to Surface Mining," "Techniques for Rehabilitating Surface Mined Lands," "Potential for Rehabilitation," and "Environmental Impacts in a Larger Context." Appendixes give environmental information for the study area, regulation of mining and reclamation by the states in the region, and the occurrence and extent of coal deposits. Also included are listings of the references cited. The comments of the reviewers are reproduced. 631 N168

R74-127 STRIP-MINED LAND RECLAMATION WITH SEWAGE SLUDGE: AN ECONOMIC SIMULATION

Seitz, W. D. (University of Illinois), American J. Agricultural Economics 56 (4), 799-804 (Nov. 1974). The economic aspects of a land reclamation, sludge

R74-127 (continued)

utilization project being operated by the Metropolitan Sanitary District of Greater Chicago are simulated. The variables influencing performance most were sludge transport costs, site preparation costs, the nitrogen budget, cropping system, and source of labor in site preparation. (Author's abstract) R911

R74-128 SURFACE-MINED LAND CONSERVATION AND RECLAMATION

Illinois Department of Mines and Minerals, Division of Land Reclamation, Annual Reports, 1971, 58 pp. 1972, 32 pp. 1973, 36 pp. 1974, 35 pp. Included in the information summarized in these annual reports are applications for permits for coal and other mining and for refuse disposal; assessed valuation of acreage to be mined; amounts of bonds; overburden depth; and progress achieved in reclamation. R972-R975

## 1975

R75-1 TECHNIQUES FOR ESTABLISHING NATIVE PLANTS ON COAL MINE SPOILS IN NEW MEXICO

Aldon, E. F. (Rocky Mountain Forest and Range Expt. Sta., Albuquerque, N. M.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 21-28. This paper describes the techniques required for successful revegetation in the New Mexico area. Since much of this area receives less than 8 inches of rain a year, supplemental irrigation is needed for year-round reclamation. Sprinkler irrigation systems were installed at two demonstration sites. Direct seeding and transplanting were done with emphasis on native species. Survival and growth were measured at 13 and 22 months because at least two growing seasons are needed to evaluate planting success in the Southwest. R691

R75-2 A VENTURE INTO RECLAMATION

Balzer, J. L., Crouch, D. B., Poyser, R. W., and Sowards, W. (Utah International, Inc.), Mining Congr. J. 61 (1), 24-29 (1975). The reclamation program of Utah International, Inc. which operates the Navajo mine near Farmington, New Mexico began in 1966. The work was coordinated with ash disposal of the Four Corners generating plant. Studies were set up to test the ability of overburden to support vegetation and to evaluate the use of mulches, soil amendments, and irrigation, and the growth potential of numerous species. Native plants fared better than non-native plants and supplemental irrigation proved necessary. At least two years are required to evaluate a reclamation program and to find out whether planting will maintain itself. The information will be used in planning reclamation of regarded land to support grazing. R571

### R75-3 KEYS TO SUCCESSFUL RECLAMATION IN WESTERN KENTUCKY

Barnhisel, R. I. (1), Powell, J. L. (2), and Akin, G. W. (1) [(1) Univ. Ky. and (2) Peabody Coal Co.], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 140-151. Reclamation projects carried out in western Kentucky at several different sites are described in detail. The projects show that key factors in reclamation include site preparation, appropriate soil amendments, and selection of plant species. R720

### R75-4 BIG BACKHOE ENTERS THE SCENE AS AN OVERBURDEN EXCAVATOR

Coal Age 80 (7), 126-128 (1975). Adam Eidemiller, Inc. of Greensburg, Pa., uses a heavy-duty backhoe to remove overburden in strip mining coal. This equipment handles all overburden, including large boulders. The preplanned restoration of the site, which will include a golf course, uses the stockpiled overburden. R620

### R75-5 COAL SURFACE MINING RECLAMATION COSTS - APPALACHIAN AND MIDWESTERN COAL SUPPLY DISTRICTS

Bitler, J. R. and Evans, R. J. (U.S. Bur. Mines, Pittsburgh, Pa.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 58-64. The Bureau of Mines conducted an investigation into the costs of surface-mining reclamation in a study covering 20 mine sites in the Appalachian and midwestern coal districts. Information was obtained from mining companies, on-site observations, and cost estimating procedures. The costs were figured as dollars per acre or dollars per ton for three phases of reclamation: planning, backfilling, and revegetation. R714

### R75-6 PERRY BROS PERFORM SUPERB RECLAMATION

Blakely, J. W., Coal Mining Process. 12 (3), 36-39 (1975). The operating procedures and the reclamation efforts of the Perry Bros. Coal Company, operating in Butler, Lawrence, and Mercer counties in western Pennsylvania, are described. Pictured also are farm land, recreation areas, and lakes that have been developed on the mined land. R592

### R75-7 THE SCRAPER IN SURFACE MINING

Blakely, J. W., Coal Mining Process. 12 (6), 68-71, 86 (1975). The effectiveness of the self-propelled scraper for both the surface mining and reclamation work of companies in Ohio and Pennsylvania is described. Scrapers have a particular advantage in their use for segregating topsoils. R617

R75-8 ECONOMIC SYSTEM ANALYSIS OF LARGE-SCALE SURFACE COAL MINING

Boyce, T. A. (Fluor Utah Inc.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 65-79. This paper reviews the development of a computerized modeling system to analyze the technical and financial aspects of large-scale surface mining. The system can be used when a description of the coal deposit and surrounding geography is available. The model is illustrated with detailed chart and tabular information. R715

R75-9 GROUND STABILITY IN SURFACE COAL MINES

Brawner, C. O., Pentz, D. L., and Campbell, D. B., Mining Congr. J. 61 (6), 42-53 (1975). Typical problems in stability of highwall slopes, pit floors, spoil piles, and waste embankments, and methods of dealing with them are discussed. The five case examples are taken from Canadian and Australian mining. R625

R75-10 EVALUATION AND RECOMMENDATIONS OF STRIP MINE RECLAMATION PROCEDURES FOR MAXIMUM SEDIMENT-EROSION CONTROL AND WILDLIFE POTENTIAL

Brenner, F. J. (1), Crowley, R. H. (2), Musaus, M. J. (1), and Goth, J. H. (1) [(1) Grove City College (2) Soil Conservation Serv., USDA], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 2-23. This project evaluated a variety of different reclamation practices on a series of strip mines in Mercer County, Pa. Survival and growth rate of different plant species were calculated and compared with those appearing through natural succession for different mines. The food value of those different plants for wildlife was determined. These studies indicated that strip mines can be reclaimed with a variety of species that provide maximum sediment and erosion control at a minimum cost to the land owner or mine operators. (From authors' abstract) R710

R75-11 COAL WASTE STABILIZATION BY ENHANCED VEGETATION

Capp, J. P., Gillmore, D. W., and Simpson, D. G. (U.S. Bur. Mines), Mining Congr. J. 61 (5), 44-49 (1975). The U.S. Bureau of Mines reclamation program on the use of fly ash as a stabilizing and vegetation agent for surface mine spoil, refuse dumps, and gob piles is described. The 13 test sites and the power plants providing the fly ash are specifically identified. Analyses of fly ash for a number of major elements and several trace elements are tabulated. Some conclusions from the work are that vegetation can be established on coal waste areas with the use of fly ash; that weathering of fly ash-spoil mixture improves the success of revegetation; and that tree plantings are more effective after ground cover of grasses and legumes has been established. Costs are also discussed. R614

## R75-12 SOIL DEVELOPMENT ON SURFACE MINE SPOILS IN WESTERN ILLINOIS

Caspall, F. C. (Western Ill. Univ.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 221-228. The rate of soil development was studied by analyzing soil profiles on graded mine spoils more than thirty years old. Samples taken at one half inch intervals were examined for organic matter, pH, texture, carbonate mineral content, and exchange capacity. Preliminary results suggest that organic matter accumulations in twenty to thirty years can be equivalent to those contained in undisturbed soils that have been under continuous cultivation. In a similar time period the carbonate mineral content in surface layers was reduced significantly. Texture, pH, and exchange capacity all show similar degrees of soil profile redevelopment. It is estimated that a new productive soil can be re-established on properly levelled surface mined lands in less than thirty years. (From author's abstract) R726

## R75-13 HORIZONTAL HAUL METHOD: A COST EFFECTIVE METHOD OF MINING MULTIPLE COAL SEAMS

Connell, J. P. (W. A. Wahler and Associates), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 99-118. This paper discusses the economics of pit mining which is different from the conventional strip mining. The plan concerns a large mining pit 4 square miles and containing 12 coal seams. Material handling in this circumstance is unique because of the various layers of refuse material. This paper outlines the most practical way to remove coal while handling the refuse in the most economical and feasible way. Various depth conditions are used as examples. Exposure of considerable coal using horizontal haul methods might cause undue weathering particularly of western coal thus decreasing market value. The author includes much financial tabulated data to show how capital expenses and costs fluctuate over the mining period. R717

## R75-14 CURRENT AND RECOMMENDED OVERBURDEN HANDLING AND RECLAMATION PRACTICES AT WESTERN SURFACE COAL MINES

Cook, F. X., Jr. (1), Gantner, G. K. (2), and McNay, L. M. (3) [(1) Mathematica, Inc. (2) Ford, Bacon, Davis, Inc. (3) U.S. Bur Mines], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 215-236. Information on material handling of both overburden and mining operations in the surface mines in western United States was obtained by visits to 25 mines. Where multiple coal seams are involved, interburden causes considerable production loss. Draglines are used for most mining operations but more adaptable equipment would be desirable. Grading, loading, and hauling are discussed as well as environmental considerations. Mining situations are classified and each condition is described. Pitching coal seams have unique situations which tax dragline operations. A list of recommendations is given for better ways to use existing draglines. Research is needed to improve multiple-seam mining

R75-14 (continued)

operations. Problems of revegetation are also discussed. R707

### R75-15 THE COAL INDUSTRY AND THE ULTIMATE IN NOISE

Coonan, G. R. (Peabody Coal Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 203-220. This paper discusses the subject of noise, its effects, standards and their significance, and existing and proposed regulations. The author outlines the problems of noise in coal operations: strip mining, blasting, and coal preparation plant noise levels. He includes a number of graphs and sketches showing noise measurements related to hearing loss and annoyance values. A number of noise descriptions are given and several case studies are included as bases for specific noise limitations. Suggestions are made for coal company noise control programs. R727

### R75-16 RECLAMATION FORGES AHEAD THROUGHOUT THE LAND

Cornforth, C., Coal Mining Process., 12 (1), 50-53, 72, 74 (1975). This is a review of reclamation of land strip mined for coal throughout the United States. Examples are cited of advances as well as of the problems still being faced. R561

### R75-17 BIOGEOCHEMICAL LIMITATIONS ON WESTERN RECLAMATION, THE HIGH NORTHERN GREAT PLAINS EXAMPLE

Curry, R. R. (Director, Sierra Club Res.), A Preprint, Practices and Problems of Land Reclamation in Western North America Symp. (Revised March 1975). 49 pp. The role of soil in reclamation of the Northern Great Plains is discussed with emphasis on the production of a stable, continuing soil-plant system. The influence of long-term climatic variations is also considered. Vegetative changes on lands which have had a variety of uses and have been subjected to varying reclamation efforts are evaluated. The author's concluding concern is that although vegetative cover may be successfully established, true reclamation will not result unless vegetation can be sustained indefinitely into the future without man's continuing efforts. R607

### R75-18 ARID ZONE HYDROLOGY, ALLUVIAL VALLEY FLOORS AND THE HYDROLOGIC BALANCE

Davis, R. W. (Consulting Hydrogeologist), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 40-48. The terms used as the title of this paper are defined and discussed. Comments are made on the need for better understanding of the terms "one-hundred year flood" and "aquifier." The author's concern with correct use of terminology results from his perception that "words and phrases, pulled out of context, are creating issues where none should

R75-18 (continued)

exist. Reasonable, working definitions of technical terms would save the country time and money." R693

### R75-19 OPEN CAST COAL MINING: THE FUTURE AND THE ENVIRONMENT

Davison, D. J. (Managing Director, NCB Opencast Executive), Colliery Guardian 223 (5), 176, 178, 180-181 (1975). Reclamation of strip-mined land in Britain, carried out simultaneously with mining, includes return to agricultural or forestry uses, replacement of fixed equipment, and sometimes restoration to recreational areas. Mining and reclamation are also coordinated with construction of the M.1 Motorway. Noise, dust, and visual impact of the mining operation are also controlled. R624

### R75-20 DRAINAGE HANDBOOK FOR SURFACE MINING

West Virginia Dept. Natural Resour., Div. Planning Develop. and Div. Reclam., Revised Jan. 1, 1975. 372 pp. The handbook gives detailed criteria for sediment control structures required for mining in West Virginia. Specifications for Valley Fill method of overburden placement are included. R604

### R75-21 ECONOMIC IMPACT OF RECENT RECLAMATION LAWS

Dreese, G. R. (W. Va. Univ.), Summary of Paper Presented Am. Assoc. Advancement Sci., Ann. Meet., New York, Jan. 1975. 6 pp.+ The author concludes that according to his evaluation of economic data of the coal industry and reclamation laws in effect in 1972, reclamation laws resulted in a statistically significant lowering of production and employment, although the size of the impact is relatively small except for Ohio and West Virginia. The industry seems to be able to adjust, although this view may be modified as further experience is collected. R567

### R75-22 ECONOMIC ENGINEERING ANALYSIS OF U.S. SURFACE COAL MINES AND EFFECTIVE LAND RECLAMATION

Skelly and Loy, Engineers-Consultants, Contract Rept. S0241049 to U.S. Bur. Mines, OFR-74-75 (1975). (654 pp). NTIS, PB-245 315/7WN. Bituminous coal surface mining in the United States is analyzed in four regions related by similar geologic and topographic conditions. Anthracite surface mining and German brown-coal surface mining are also considered. Mining and reclamation methods, economic considerations, and descriptions of the area are given for each region. Economic studies of case histories in each of the four regions are also included. 631 S6

R75-23 PRE-DISTURBANCE ECOLOGICAL STUDIES IMPROVE AND DEFINE POTENTIAL FOR SURFACE MINE RECLAMATION

Fisser, H. G. and Ries, R. E. (Univ. Wy.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 128-134. This paper describes a reclamation study made on a lease area where Atlantic Richfield Co. has proposed to surface mine coal. Physical details of the area are given plus the year-round weather conditions. Existing vegetation conditions were sampled and developmental stages of individual plant species were followed through the 1973 field season. Ground-cover characteristics evaluated were bare soil, rock, erosion pavement, lichens, and litter. Disturbed areas were sampled in the same manner as the undisturbed areas. Results of the study are outlined in detail and tabulated. Specific restoration techniques are recommended. Native short mixed grasses and some fertilization and irrigation are the most acceptable approaches for these areas. R699

R75-24 REGIONAL ASPECTS OF PLANNING TO INCREASE PRODUCTION AND ENHANCE RECLAMATION

Gunnett, J. W. (Skelly and Loy, Engineers-Consultants), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 95-127. The paper presents the pertinent results of a project performed for the Bureau of Mines titled "Economic Engineering Analysis of U.S. Surface Coal Mines and Effective Land Reclamation." In particular, discussions are directed toward mine planning as it relates to production and reclamation, and are related to four distinct geographic regions. See R75-22. (Adapted from Introduction) R698

R75-25 SPECIAL PROBLEMS AND ASPECTS OF SURFACE MINING IN ALABAMA

Hagen, H. D. (The Drummond Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 13-15. The author describes the short-lived development of the "spot" market which produced many short-term operators who then were forced out of business by the drop in coal prices. He also points out the adverse effects of the vetoed reclamation bill on Alabama coal development and describes the development of a strong state reclamation law. R689

R75-26 UTILIZATION OF PHOTOGRAMMETRY AND MODERN COMPUTER TECHNIQUES TO CALCULATE MONTHLY PRODUCTION QUANTITIES FOR STRIP MINES

Hickerson, H. C. (Park Aerial Surveys, Inc.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 200-208. This author describes how aerial-photography measurements of strip-mine areas can be used with computers and related equipment to determine overburden and strip-mine coal production. Details of equipment are included as well as discussion of programming, collection of input data, and calculation of quantities. Pits are usually

R75-26 (continued)

photographed once each month and additional data are added by the mining engineers. Accuracy and reliability are somewhat controlled by weather conditions but this is not a serious limitation. When done on a regular basis, the information serves as a permanent record of surface mining activities. R705

R75-27 HORNE BROS. MINE - BEST OF THREE WORLDS

Coal Mining Process. 12 (2), 38-39,50 (1975). The Horne Brothers Mining Co. in Wise, Virginia uses an effective haulback method and mountaintop removal system to reclaim their strip-mined properties. The overburden is hauled directly to an old strip pit being backfilled. The graded, reclaimed area is hydroseeded and disked. Since the mined area is only two miles from town, the property will be developed for housing. R579

R75-28 THREE NEW TOOLS FOR IMPROVING LAND RECLAMATION EFFICIENCY

Howland, J. W. (Pittsburg & Midway Coal Mining Co.), Mining Congr. J. 61 (3), 20-21 (1975). Pittsburg & Midway Coal Co. has designed attachments to earthmoving equipment for use in its reclamation program. The tools described are a 40-foot angle blade, a 24-foot vee-plow, and 30-foot grading bars. R596

R75-29 SURFACE MINING AND RECLAMATION OF THE STEARNS #2 COAL IN SOUTH CENTRAL KENTUCKY

Jasper, D. (Jasper & Associates, Inc., Somerset, Ky.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 237-241. Usually some of the overburden strata are acid bearing and the seam is often located just above the Pennington Shale formation which is unstable if loaded with a fill bench. Special mining and reclamation procedures are required to prevent land slides and provide revegetation. The purpose of this presentation is to discuss the development and application of the procedures and to present a case history of an active mine being operated under these procedures. (From Introduction) R705

R75-30 FORAGE GRASSES AND THE TRANSITION FROM SPOIL TO SOIL

Jones, J. N., Jr., Armiger, W. H., and Bennett, O. L. (Agr. Res. Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 185-194. This paper reports the results of a 4-year revegetation project conducted near Beckley, W. Va. on a regraded spoil bench on White Oak Mountain. The study evaluated the response to several soil amendments of four grass species, and the status of the spoil profile which was developed. Conclusions state that mine spoil can be improved in a relatively short time using appropriate forage grasses and soil amendments. R723

### R75-31 SURFACE MINING AND ENVIRONMENTAL NOISE DATA ACQUISITION AND ANALYSES

Kerch, R. L. (Amax Coal Co., Indianapolis, Ind.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 195-202. The in-house noise-control program set up by Amax Coal Co. is guided by compliance with the state of Illinois Rules and Regulations for Noise Pollution Control. A data base for equipment noise levels was obtained and used to predict noise problems. It also can aid in alleviating problems or in monitoring cases where there may be non-compliance. R724

### R75-32 PILOT PLANT EVALUATION OF SOIL LOSSES FROM DISTURBED LAND

Kirkpatrick, J. C. (1), Seith, R. T. (2), and Allen, O. R. (2) [(1) Gilbreath, Foster and Brooks, Inc. and (2) Gulf States Paper Corp.], Natl. Coal Assoc./ Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 24-41. In this project, a test facility was used to conduct various experiments involving sedimentation and erosion control. Seven different test procedures were used and the data applied to the Universal Soil Loss Equation. Monitoring procedures are detailed and the data information is given in chart form. It was concluded that the Soil Loss Equation does not accurately predict sediment yield on slopes greater than 5:1. Continued experimentation will be necessary to develop accurate and economic means of monitoring sediment yield. It was also decided that the use of basins does not produce the accuracy desired. R711

### R75-33 LAUREL RUN REVISITED

Green Lands 5 (1), 2-8 (1975). The controversy over mining an area designated as "Laurel Run" near Bruceton Mills, West Virginia, in 1971 is summarized. Photographs show the reclaimed area after completion of mining. R593

### R75-34 DENTS RUN WATERSHED PROJECT

Light, B. A. (Consolidation Coal Co., Christopher Coal Co. Div.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 148-151. Consol's part in the cooperative project to clean up the watershed, located in northern West Virginia, was concentrated on treating six discharges from the Osage Mine. The two treatment plants built for combined discharges are described. Typical analyses of rain and treated water show the success of the treatment plants in meeting water quality standards. R701

### R75-35 THE EFFECTS OF MODERN STRIP MINING ON WATER RESOURCES

Light, E., Campaign Clean Water, Charleston, W. Va., March 1975. 18 pp.

R75-35 (continued)

Information from 51 references is used in this discussion of sedimentation, water quality, and changes in hydrology resulting from strip mining. 75-1

### R75-36 SURFACE MINING OF COAL AT SPARWOOD, B.C.

Livingstone, G. K. (Kaiser Resources Ltd.), Can. Mining Met. Bull. 68 (757), 81-85 (1975). At Sparwood, B.C., Kaiser Resources Limited obtains 85% of its raw coal production from surface mining. The strip mining procedures, which the paper discusses in detail, are conducted on a scale necessitating the use of some of the largest equipment available. Included are sections on geology, mine planning, production methods, waste disposal, equipment maintenance, quality control, safety and land reclamation. (Author's abstract) R612

### R75-37 METHODS OF LIQUID FERTILIZER APPLICATION

Lynam, B. T. and Carlson, R. O., Proceed. Conf. Land Disposal of Municipal Effluents and Sludges, New Brunswick, N. J., by U.S. EPA, Region II, and Rutgers Univ., College Agr. Environ. Sci., March 12-13, 1975. pp 82-87. The Metropolitan Sanitary District of Greater Chicago used tank truck, irrigation systems, and an incorporation method for applying anaerobically-digested sewage solids over a strip-mined area in southern Illinois. R603

### R75-38 THE ROLE OF THE SOIL CONSERVATION SERVICE'S PLANT MATERIALS CENTER IN RECLAIMING SURFACE-MINED LANDS

MacLauchlan, R. S. (Soil Conservation Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 131-139. The Soil Conservation Service operates plant material centers throughout the country to meet conservation and revegetation needs. Grasses, forbs, trees, and shrubs are evaluated for use in erosion projects of all kinds. The service has greatly increased its activity in the field of surface-mine reclamation. Many of the plant species which have been confirmed for mine-spoil reclamation in all areas are described. R719

### R75-39 RECLAIMING LAND FOR RECREATIONAL DEVELOPMENT, PART I

Maneval, D. R., Coal Mining Process. 12 (4), 84-86 (1975). Advantages of reclaiming strip-mined land for recreation include generally low cost, ready access, availability of utilities, and lakes created by mining. The author notes government agencies which can provide financial and technical aid. R618

### R75-40 RECREATIONAL DEVELOPMENT ON RECLAIMED LAND, PART 2

Maneval, D. R., Coal Mining Process. 12 (6), 74-76 (1975). This article describes several reclamation projects in Pennsylvania where new or improved recreational facilities were developed. R619

### R75-41 CHARACTERIZING OVERBURDEN MATERIALS BEFORE SURFACE MINING IN THE FRUITLAND FORMATION OF NORTHWESTERN NEW MEXICO

Miyamoto, S., Gould, W. L., and Rai, D. (N.M. State Univ., Dept. Agronomy), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 80-94. This paper gives the results of a vegetative survey and soil- and overburden-characterization studies in northwestern New Mexico where coal mining is proposed. The area is semi-arid, receiving about 7-1/2 inches of annual rainfall. The surface materials are mostly rough with heavy sand. Soil characteristics were related to chemical properties. It was suggested that spoil materials be topdressed with surface sands as the most reasonable way of conducting revegetation work. Soil amendments were also recommended to improve shale and sandstone properties. R697

### R75-42 SURFACE MINE REHABILITATION IN NORTHWESTERN COLORADO

Moore, R. T., Koehler, D. A., and Kling, C. L. (Ecology Consultants, Inc.) Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 171-184. This paper evaluates reclamation conducted by the Peabody Coal Co. at the Seneca 1 and 2 mines, beginning in 1965. The history of the reclamation progress is included and vegetative surveys of the areas are tabulated. Among the conclusions are that seeded areas should be protected from grazing until plants are established; without fertilization, some nitrogen-fixing species are important to establishment of other species; wildlife may use the revegetated areas for foraging, but need vegetation to meet food and cover requirements in order to be reestablished permanently. R722

### R75-43 EVALUATION OF SEDIMENTATION PONDS USED IN SURFACE COAL MINING

Nawrocki, M. A. and Kathuria, D. V. (Hittman Associates, Inc.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 42-47. In this project the objective was to determine the overall effectiveness of sedimentation ponds in removing suspended solids. Nine ponds in Kentucky, Pennsylvania, and West Virginia were selected for the program. Field sampling was done to learn effiencies of removal in runoff flows. Water quality measurements and flow rates were recorded at both the influent to and effluent from the ponds. Characteristics of the ponds are listed and individual descriptions are also given. The ponds had a wide range of suspended-solids removal efficiencies during rainfall conditions. Results indicated that the efficiency of dugout-type ponds built off the natural waterway is greater than of ponds built

R75-43 (continued)

across the natural waterway. R712

R75-44 THE COSTS OF COAL SURFACE MINING AND RECLAMATION IN APPALACHIA

Nephew, E. A. (1), Spore, R. L. (1), Foreman, J. W. (2), and Carlin, D. F. (2) [(1) Oak Ridge National Lab. and (2) Gwin, Dobson and Foreman, Inc.], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 119-130. This paper presents results of a study designed to estimate the costs of coal surface mining and reclamation in northern Appalachia. Engineering and cost analyses of 28 individual model mines were performed. The mines were chosen to represent various combinations of mining and reclamation techniques applied to three alternative slopes and two alternative overburden-to-coal ratios typical of the area. Each mine was assumed to be an on-going, continuous operation over 1000 linear feet of bench. Detailed engineering cost analyses were performed for each of 9 unit operations. In addition, total costs including a normal profit based on a 12 percent discounted cash flow rate of return are estimated. Summary analyses provide estimates of the costs of mining and reclamation as a function of the angle of the terrain and overburden-to-coal ratio. (From authors' abstract) R718

R75-45 A MODEL TO ANALYZE THE COSTS OF STRIP MINING AND RECLAMATION

Otte, J. A. and Boehlje, M. (Iowa State Univ.), Natl. Coal Assoc. /Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 80-98. This study involves the development of a computer program where the owner can accurately estimate mining and reclamation costs relative to opening a new surface mine. The model takes into account the particular equipment and handling methods to be used and basic information on the project mine. Extensive details on data base information are given and cost figures are tabulated, especially for machine operation. Examples are included showing how the model was applied to simulated mining conditions. Overhead costs can also be determined using this model. R716

R75-46 RELATIONSHIP OF GROUND-WATER MOVEMENT AND STRIP MINE RECLAMATION

Pennington, D. (John McCormick and Associates, Devon, Pa.), Natl. Coal Assoc./ Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 170-178. This paper describes the surface conditions and the underground water conditions in the Mahanoy Creek watershed of eastern Pennsylvania. Since water enters the drainage system from outside the watershed and moves miles through a series of more than thirteen interconnected underground-mine pools, strip-mine reclamation in the area has not significantly reduced mine drainage. The reduction of discharges brought about by surface reclamation and the costs of the improvements are tabulated. R703

R75-47 CHANGES IN WATER CHEMISTRY RESULTING FROM SURFACE-MINING OF COAL ON FOUR WEST VIRGINIA WATERSHEDS

Plass, W. T. (Northeastern Forest Expt. Sta., Princeton, W. Va.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 152-169. Also in Green Lands 6 (1), 22-27 (Winter 1976). Water quality in contiguous watersheds was monitored from May 1969 through April 1974 in order to provide much needed information on normal variations in water quality so that valid comparisons of water quality before and after mining can be made. Sampling was done every two weeks and analyses were made for pH, specific conductance, alkalinity, sulfate, calcium, bicarbonate, magnesium, iron, aluminum, manganese, zinc, and potassium. Results of analyses were evaluated for before-mining variations between samples taken in growing and dormant seasons and for water years 1970, 1971, and 1972 which cover a wide range of precipitation. Also, each factor for which analyses were made is discussed and the effect on the parameter of mining in the various watersheds is evaluated. R702

R75-48 PRELIMINARY RECOMMENDATIONS FOR SEEDING PINE ON SURFACE MINE SPOILS

Plass, W. T. (U.S. Forest Service), Green Lands 5 (1), 19-20 (1975). The recommendations and observations based on experience of the author during the past three years are: (1) Site selection and seed are important, and locations should be limited to elevations below 2,000 feet; (2) Low pH values do not restrict southern pine species which have done well on direct seeding; (3) Scarifying areas and phosphate fertilization may increase growth; (4) Grass and legume covers can present excessive competition for young seedlings: (5) A quick developing tree or shrub nurse crop can protect the young pines which may take three years to reach a foot in growth; and (6) All seed should be treated with bird and insect repellent. Jour

R75-49 WATER QUALITY MODELS FOR A CONTOUR MINED WATERSHED

Plass, W. T. (1), Connell, J. F. (2), Contractor, D. N. (2) and Shanholtz, V. O. (2) [(1) Northeastern Forest Expt. Sta., Princeton, W. Va. and (2) VPI and SU], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 179-199. The production of sulfate and other chemicals at a strip mine and its transport to local streams is a complex process that involves the kinetics of the chemical reactions and the hydrology and geology of the area. This study attempts to understand the interactions involved and to relate various water quality parameters to the hydrology of the area. Data was furnished by the Northeastern Forest Experiment Station, Princeton, W. Va. from the Stover B watershed which they had monitored. (From Introduction) R794

R75-50 PROCEDURE FOR OBTAINING A SURFACE MINING PERMIT IN WEST VIRGINIA

West Virginia Surface Mining and Reclamation Association (undated). 58 pp.+ This booklet gives instructions for complying with the 1971 West Virginia

R75-50 (continued)

Surface Mining Law and examples of the completed forms necessary to obtain a surface mining permit. The text of the law and the regulations in effect are in appendixes. R590

R75-51 ESTIMATE OF RECLAMATION COSTS RESULTING FROM FEDERAL LAW

Pundari, N. B., Coal Age 80 (4), 127-131 (1975). Estimates are developed for tangible, intangible, and total reclamation costs (per acre and per ton), due to the proposed surface mining and reclamation act, for coal seam thicknesses from 1 to 100 ft under surface slopes of 2°-20° at 2° increments with box-cut depth at 25 ft, and final cut depth at 200 ft. (From text) Jour

R75-52 CONTROLLING SEDIMENT FROM CONSTRUCTION AREAS

Reed, L. A. (U.S. Geol. Surv., Harrisburg, Pa.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 48-57. In this project three different methods were tried to find out the most efficient method of controlling sedimentation and runoff from active construction areas. Treated watersheds were compared to a watershed with no sediment control and to a watershed with no construction. Results showed that large ponds may be effective control measures but rock dams and barriers were not satisfactory. A number of pictures, sketches, and graphs illustrate the project which included in-stream and off-stream sediment ponds. R713

R75-53 REPORT ON WATER FOR ENERGY IN THE NORTHERN GREAT PLAINS AREA WITH EMPHASIS ON THE YELLOWSTONE RIVER BASIN

U.S. Dept. Int., Water for Energy Management Team, January 1975. (115 pp + foldout map). This report covers all water requirements for energy purposes in the 63 counties of Wyoming, North Dakota, and South Dakota located in the upper Missouri River Basin. Chapter IV provides a discussion of water needs for coal processing and for revegetation and reshaping of mined areas. Complete restoration is estimated as a 5-year effort based on an average annual rainfall of about 12 inches. R600

R75-54 SURFACE-MINED LAND RECLAMATION IN SOUTHEAST KANSAS

Robertson, D. R. (Soil Conserv. Serv., USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 229-239. This author discusses the broad-based reclamation work in southeast Kansas, where conservation associations, private citizens and government agencies have cooperated in a number of demonstration projects. He gives the history of surface mining, the early reclamation work, the role of the Soil Conservation Service, and development of state reclamation laws. In two counties, specific projects involved some 15

R75-54 (continued)

grasses on spoil material. Crownvetch has been the most successful legume especially for sloping areas. A number of shrubs were also planted. Cardinal autumn-olive and Arnot bristly locust have been outstanding. R727

R75-55 THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM AND THE COAL INDUSTRY

Schaffer, R. B. (U.S. EPA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 2-6. The regulations and requirements of the Federal Water Pollution Control Act of October 18, 1972 are discussed and individual coal mining activities which require permits are itemized. Special conditions included in the act allow an operator to by-pass his water treatment plant in the event of a "major precipitation event." R687

R75-56 METHODS OF SELECTING PROPER PERSONNEL TO CONDUCT ENVIRONMENTAL BASELINE STUDIES REQUIRED FOR RECLAMATION PLANNING

Scott, M. D. (Amax Coal Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 70-79. This paper describes the types of personnel available to do environmental studies and discusses the merits and disadvantages of each. Of the three categories, company employees, private consultants, and public consultants, evaluated by economic factors, credibility and reliability, the author rates public consultants (primarily college faculty members) as slightly better qualified to do environmental studies. R696

R75-57 RECLAMATION RESEARCH IN THE ROCKY MOUNTAIN FOOTHILLS

Selner, J. E. (Alberta Dept. Energy Natural Resour.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 16-20. Reclamation technology required in the Canadian Rocky Mountain areas is in an early stage of development. The growing season is short and steep terrain restricts type of planting which is suitable; also some coal seams occur above the green line. The Alberta Forest Service has conducted reclamation work at higher elevations and the foothill areas. Lists of the various species used at each location level are given. R690

R75-58 BETTER MINESOILS BY BLENDING?

Smith, R. M., Grube, W. E., Jr., and Freeman, J. R., Green Lands 5 (1), 16-18 (1975); W. Va. Agr. Expt. Sta., Sci. Paper No. 1359. The authors suggest that blending neutralizing strata with acid material can prevent acid toxicity and have the additional advantage of allowing flexibility in spoils placement to improve minesoil fertility and physical properties. R594

### R75-59 PREPLANNING FOR COAL PRODUCTION AND RECLAMATION OF MINED LANDS

Stamm, G. G. (U.S. Bur. Reclamation), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 62-69. The circumstances involved in mining the huge western coal deposits, particularly the problem of water supply, are discussed in detail. Government work on obtaining base line data and planning for reclamation is described. R695

### R75-60 STRIP MINE RECLAMATION DRAWS 14 BIDDERS

Eng. News Rec. 194 (7), 41 (Feb. 13, 1975). The two lowest bids for reclaiming an abandoned northern Pennsylvania strip mine are compared and the work to be done is listed and described. R583

### R75-61 STRIP MINE SITE BECOMES VINEYARD

Coal Mining Process. 12 (2), 23 (1975). The Falcon Coal Co. of Breathitt County, Kentucky, has planted 5 acres of strip-mined land with about 400 vines of seven varieties of French hybrid grapes. The harvest will be used in wine making. R580

### R75-62 TECHNOLOGICAL INNOVATIONS ABOUND IN COAL MOUNTAINS OF APPALACHIA: SURFACE MINING AND RECLAMATION

Coal Age 80 (6), 265-273 (1975). The article describes haulback mining in eastern Ohio, modified block cutting in southwestern Pennsylvania, the longwall stripping program in West Virginia, and various methods of controlled placement of overburden in mining steep slopes. R621

### R75-63 HYDROLOGY OF BLACK MESA RECLAIMED LAND

Thames, J. L., Patten, R. T., and Crompton, E. J. (Univ. Ariz., Dept. Watershed Management), Mining Congr. J. 61 (7), 16-20 (1975). A study by Peabody Coal Co. and the University of Arizona is being made on two watersheds, one on reclaimed land and one on an undisturbed 5-acre area. Both have been instrumented to measure a number of hygrologic variables including precipitation, amount and quality of run-off, and spoil permeability. R627

### R75-64 VEGETATIVE REHABILITATION AND EQUIPMENT WORKSHOP

Tixier, J. S. (Forest Service, USDA), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 242-243. The workshop is an unchartered organization of Federal, state, and industry representatives whose interest for more than 30 years has been in promoting development of equipment for revegetation. Field testing and evaluation of custom designed or successfully modified

R75-64 (continued)

equipment has resulted in the development of a number of much needed publications. R709

### R75-65 PROBLEMS ASSOCIATED WITH MINE DEVELOPMENT ON FEDERAL COAL

Tobler, R. H. (Amax Coal Co.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 8-11. This paper outlines the procedure required for a coal company to develop a coal mine operation on Federal coal-reserve property in the western states with State and Federal requirements for a hypothetical use in Montana as an example. The problems introduced by proposed "diligence requirements" are also discussed. R688

### R75-66 REQUIREMENTS AND USE OF FERTILIZER, LIME, AND MULCH FOR VEGETATING ACID MINE SPOILS

Vogel, W. G. (Northeastern Forest Expt. Sta., Berea, Ky.), Natl. Coal Assoc./ Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 2, Louisville, Ky. (1975). pp 152-170. Mulch, in addition to lime and N and P fertilizers, was required for successful establishment of grasses and legumes seeded on extremely acid spoils (pH 2.2 to 3.5) in eastern Kentucky. With only lime and fertilizer, a sparse vegetative cover (mostly grass) became established; but where a mulch of shredded bark also was applied, a good cover of grasses and legumes was established. The plants were rooted only in the layer of spoil into which the lime had been incorporated (2 to 4 inches deep). The mulch reduced evaporation and maintained moisture in this rooting zone. (Author's abstract) R721

### R75-67 VERTICAL DISTRIBUTION OF SULFUR FORMS IN SURFACE COAL MINES SPOILS

VonDemfange, W. C. (1) and Warner, D. L. (2) [(1) Old Ben Coal Co. and (2) Univ. Missouri-Rolla], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 135-147. These authors report a project in which sulfur forms were measured at various depths in spoil piles in Henry County, Mo. Samples were taken as deep as 20 feet. Sulfide and sulfate measurements show that by far most of the oxidation occurs in the top 2 feet. This area accordingly produces most of the acid and permits predictions of acid production to be made. Two feet of cover were found to be sufficient to prevent pyrite oxidation. Leveling of the spoil pile should not be done without additional cover since this exposes more pyrite to oxidation. R700

### R75-68 MINED-LAND REVEGETATION WITHOUT SUPPLEMENTAL IRRIGATION IN THE ARID SOUTHWEST

Wahlquist, B. T. (1), Dressler, R. L. (1), and Sowards, W. (2)

R75-68 (continued)

[(1) Westinghouse Electric Corp. and (2) Utah International Inc.], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 29-39. Near the Navajo Mine in the northwestern corner of New Mexico, rainfall averages less than one inch per month. The area has traditionally been overgrazed making it difficult to develop a reasonable level of plant life. Two evaluation plots were selected mainly on the basis of spoil material and slope. Topsoil was applied to 4- to 10-inch depths and mulch and irrigation sprinklers were used. Surface manipulation appeared to produce the most successful results. Added sprinkling considerably increased seedling establishment. However, efforts in this area will give results rather slowly but reclamation is planned at about 540 acres per year. R692

## R75-69 SUCCESS WITH THE RANGELAND DRILL IN MINE SPOIL REVEGETATION

Wolcott, B. H., Jr. (1) and Vogel, W. G. (2) [(1) Ky. Reclamation Assoc. and (2) Northeastern Forest Experiment Station, Berea, Ky.], Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 209-214. This author explains how the rangeland drill can be used for strip-mine revegetation. This equipment, designed for wildland seeding in the West, can plant and fertilize in one operation, resulting in a saving in time and labor. The drill was first used in Kentucky in 1974 and the results were very satisfactory. It is rugged and can work day after day with minimum maintenance. R706

## R75-70 COAL MINE SPOIL AS A GROWING MEDIUM: AMAX BELLE AYR SOUTH MINE, GILLETTE, WYOMING

Yamamoto, T. (Rocky Mountain Forest and Range Expt. Sta., Rapid City, S. Dak.), Natl. Coal Assoc./Bitum. Coal Res., Inc., Third Symp. Surface Mining and Reclamation Preprints, Vol. 1, Louisville, Ky. (1975). pp 49-61. Results of extensive analyses of sandy overburden used in a current experimental tree and shrub adaptability project are reported and discussed. No characteristics unfavorable to plant growth were found. R694

## R75-71 AN ACTION PROGRAM FOR SOUTHEASTERN KENTUCKY'S ABANDONED COAL MINES

Tennessee Valley Authority and Kentucky Department for Natural Resources and Environmental Protection, in cooperation with U.S. Departments of Agriculture and Interior (undated). 49 pp. This report outlines Kentucky's "orphan" mine problem in 12 southeastern counties. It describes the reclamation needed, specifies costs involved, and includes a description of the administrative arrangements necessary for efficiently completing the job. (From Executive Summary) R776

R75-72 AN ACTION PROGRAM FOR TENNESSEE'S ABANDONED COAL MINES

Tennessee Valley Authority and Tennessee Department of Conservation, in cooperation with the U.S. Departments of Agriculture and Interior (undated). 50 pp. This report outlines Tennessee's "orphan" mine problem in 13 counties. It describes the reclamation needed, specifies costs involved, and includes a description of the administrative arrangements necessary for efficiently completing the job. This federally funded demonstration program was planned to be initiated in July 1975. (Adapted from Executive Summary) R780

R75-73 AN ACTION PROGRAM FOR VIRGINIA'S ABANDONED COAL MINES

Tennessee Valley Authority and Virginia Department of Conservation and Economic Development, in cooperation with U.S. Departments of Agriculture and Interior (undated). 48 pp. This report outlines Virginia's "orphan" bank problem in the six Tennessee Valley counties of southwest Virginia. It describes the reclamation needed, specifies costs involved, and includes a description of the administrative arrangements necessary for efficiently completing the job. This federally funded demonstration program was planned to be initiated in July 1975. (Adapted from Executive Summary) R775

R75-74 ENDOMYCORRHIZAE ENHANCE SURVIVAL AND GROWTH OF FOURWING SALTBUSH ON COAL MINE SPOILS

Aldon, E. F., U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station, Forest Service Research Note RM-294 (July 1975). 2 pp. Greenhouse studies and field trials on spoils at the McKinley mine in New Mexico showed that growth and survival of plantings of fourwing saltbush were improved by inoculation with G. mosseae. R997

R75-75 PROBLEMS AND TECHNIQUES IN REVEGETATING COAL MINE SPOILS IN NEW MEXICO

Aldon, E. F. and Springfield, H. W., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 122-132. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. Specific studies carried out by the Rocky Mountain Forest and Range Experiment Station in cooperation with coal companies and with universities are discussed under the following topics: spoil amendments, irrigation techniques, water harvesting, direct seeding trails, mycorrhizae, and cooperative studies with universities. (Adapted from authors' Introduction) R783, 631 W17p

R75-76 ALFALFA WAVES OVER STRIPPED COAL LANDS

Missouri's Environment 1 (6), 3 (July 1975). This article describes a tour to view the results of Project Reuse, a state-sponsored, cost-sharing program to demonstrate the feasibility of reclaiming abandoned surface-mined areas. R840

### R75-77 A PHOTOGRAPHIC TECHNIQUE FOR MONITORING EROSION ON STRIP MINED LANDS

Allen, R. H., Jr. and Curtis, W. R. (Northeastern Forest Experiment Station), Photographic Applications in Science, Technology and Medicine 10 (4), 29-31 (July 1975). A transportable gauge, which is a frame holding pins which move freely vertically, is mounted on pre-installed angle-iron stakes. Photographs are taken to record the height of the pins against the lined background of the gauge. Finished prints are run through a chart reader and information on the amount of erosion is transferred to punch cards. R752

### R75-78 LANDSAT INVENTORY OF SURFACE-MINED AREAS USING EXTENDIBLE DIGITAL TECHNIQUES

Anderson, A. T. (1), Schultz, D. T. (2), and Buchman, N. (2) [(1) NASA/GSFC and (2) General Electric Company], U.S. National Aeronautics and Space Administration, Goddard Space Flight Center, Preprint X-900-75-165 (Aug. 1975). 21 pp. NTIS, N75-33486. Multispectral analysis of LANDSAT imagery provides a rapid and accurate means of identification, classification, and measurement of strip-mined surfaces in Western Maryland. Four band analysis allows distinction of a variety of strip-mine associated classes, but has limited extendibility. A method for surface area measurement of strip mines, which is both geographically and temporally extendible, has been developed using band-ratioed LANDSAT reflectance data. The accuracy of area measurement by this method, averaged over three LANDSAT scenes taken between September 1972 and July 1974, is greater than 93%. Total affected acreage of large (50 hectare/120 acre) mines can be measured to within 1.0%. (Authors' abstract) R756

### R75-79 THE STRIP-MINING OF WESTERN COAL

Atwood, G., Scientific American 233 (6), 23-29 (Dec. 1975). Surface mining and reclamation in coal lands in the western United States are reviewed in detail. R919

### R75-80 ECOLOGY AND ECONOMICS OF STRIP-MINE RECLAMATION IN MAHASKA COUNTY, IOWA

Ballou, S. W., Ph.D. Thesis, University of Wisconsin-Milwaukee, 1975. 166 pp. University Microfilms, 76-19,335. Most of the mining on the six study sites was carried out from the 1930's into the 1950's. No reclamation was done on two sites. At one site, only regrading was done after a number of years; another site was graded and planted by the state for use as a wildlife habitat; and still another site was used as a sanitary landfill. One site, mined in the 1960's, was graded, spread with topsoil, and returned to production of corn and hay. From available historic documents, coal production and costs, estimation of agricultural production, and detailed property valuations were documented. These data, along with environmental factors at each site such as slope characteristics, spoil stability, sedimentation, acid drainage, and vegetative production, were used in a computer program to evaluate the impact

R75-80 (continued)

of mining and of various methods of reclamation. In the study area, full recovery of premining land value was obtained after reestablishment of crop productivity. 631 B19

### R75-81 RECLAMATION OF TERRAIN EXPLOITED BY LIGNITE OPENPIT MINES

Bauman, K. (POLTEGOR), in Environmental Protection of Openpit Coal Mines, Reports of the Polish-U.S. Symposium, sponsored by U.S. EPA and The Central Research and Design Institute for Opencast Mining (POLTEGOR), Wrocław, Poland, Denver, Colorado, May 27-29, 1975. pp 79-88. Published by The University of Denver Research Institute, Denver, Colorado, Sept. 1975. NTIS, PB-249 300. Methods of grading and preparing mine spoils for planting, and the revegetation studies being carried out with support of the U.S. EPA at Turow mine are described. 75-30

### R75-82 TOPSOIL AS A SEED SOURCE FOR RESEEDING STRIP MINE SPOILS

Beauchamp, H., Lang, R., and May, M., Research Journal 90, Agricultural Experiment Station, University of Wyoming, April 1975. 8 pp. Samples from the top one inch and from the second inch of soil were taken at five major coal and uranium strip-mine areas and from a potential trona mining area in Wyoming. Greenhouse studies showed that the substantial amounts of viable seed in the top two inches of each site were more than enough to revegetate the area with more than original density. However, the type of vegetation was that normally found in secondary succession and not that type which was dominant where the samples were taken, indicating that seeding or planting of desired species would be necessary. There seemed to be no relationship between soil texture and pH and amount of viable seed. CE536

### R75-83 GERMAN TECHNIQUES IN SURFACE MINING AND RECLAMATION

Benecke, K. J. (1) and Gold, R. S. (2) [(1) Krupp Industries and (2) Dr. Otto Gold Co.], Green Lands 5 (3), 18-25, 28-34 (Summer 1975). Bucket-wheel excavators have been developed for large-scale operations. German reclamation includes compliance with detailed regulations for overburden and topsoil handling and placement. R934

### R75-84 REVEGETATION OF LAND DISTURBED BY SURFACE MINING IN COLORADO

Berg, W. A., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 79-89. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. This paper concentrates on observations of and anticipated problems in revegetation of coal strip mines in northwestern Colorado, and also includes pertinent findings and observations

R75-84 (continued)

on revegetation of open pit mine wastes elsewhere in Colorado. (Adapted from author's Introduction) R783, 631 W17p

R75-85 USE OF SOIL LABORATORY ANALYSES IN REVEGETATION OF MINED LANDS

Berg, W. A. (Colorado State University), Mining Congr. J. 61 (4), 32-35 (1975). The author discusses the use of soil analyses to identify the factors of mined-land spoil that will interfere with revegetation. These factors are lack of plant available phosphorus and nitrogen; excess acidity, soluble salts, and sodium; and extremes in texture. Jour

R75-86 LAND RECLAMATION IN WESTERN ILLINOIS COAL FIELDS

Caspall, F. C. (Western Illinois University and Midland Coal Company), AIME-SME Fall Meeting, Salt Lake City, Utah, Sept. 10-12, 1975. 15 pp. Preprint No. 75-AO-324. Preliminary results of research on restoring fertile agricultural lands which have been surface-mined for coal have suggested that 1) terraces and other erosion control structures are not only feasible but represent only a fraction of the total reclamation costs and do a satisfactory job of controlling soil-erosion on moderate slopes (less than 10 percent); 2) soil profile development can be accelerated greatly by normal tillage operations on erosion-free surfaces; 3) wheat is the most desirable field crop to grow on spoils being reclaimed because it allows annual grooming of the surface. (From author's Conclusions) AIME-SME

R75-87 THE COST OF MOVING OVERBURDEN BY VARIOUS MACHINE SYSTEMS

Colvin, T. S., Anderson, C. E., and Buchele, W. F. (Iowa State University), Society of Automotive Engineers, Earthmoving Industry Conference, Central Illinois Section, Peoria, Illinois, April 15-16, 1975. 12 pp. Paper No. 750578. An overview of the Iowa State Coal Project is presented. Draglines and scrapers are compared for energy efficiency in stripping coal. Survey results on scrapers are presented which show diverse production and cost relationships indicating that many factors other than size of machine, haul distance, and grade are important. R955

R75-88 BIOGEOCHEMICAL LIMITATIONS ON WESTERN RECLAMATION

Curry, R. R., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 18-47. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. This critique of current reclamation practices on western coal lands is based on an in-depth discussion of soil and its long-term development as one of two decisive factors in ultimately successful reclamation. The other correlative factor, plant-available

R75-88 (continued)

moisture, is related to precipitation modified by climatic conditions and soil characteristics, and to vegetative species used in reclamation. Conditional reclamation, defined as relying on human efforts to augment or counteract natural forces, is contrasted to truly successful reclamation which includes progressive soil development and natural successional vegetative cover adapted to extremes of climatic and hydrologic stress. R783, 631 W17p

R75-89 DECKER COAL COMBINES TITANIC MINING EFFORT WITH EFFECTIVE LAND RESTORATION

Coal Age 80 (10), 118-120 (Sept. 1975). At the Tongue River mine of the Decker Coal Co. at Decker, Montana, the topsoil is carefully removed and stockpiled. Dust is controlled with water sprays. Mine water goes first to a settling pond before entering natural drainage. Decker uses special test plots to determine the best ground cover to use in revegetation. Cooperation with several public agencies insures a complete and finished reclamation effort soon after coal is mined. Jour

R75-90 DEVELOPMENT OF LAND RECLAMATION IN BRITISH COLUMBIA

Dick, J. H. and Thirgood, J. V., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 65-78. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. The purpose of this paper is to discuss the environmental and institutional circumstances affecting reclamation in British Columbia, what has been learned, the problems and failures, and to speculate on the direction that mined land reclamation must take if mining is to become more compatible with other resource uses in the Province. (Adapted from authors' Introduction) R783, 631 W17p

R75-91 CHEMICAL RECLAMATION FOR SODIC STRIP-MINE SPOILS

Doering, E. J. and Willis, W. O. (Northern Great Plains Research Center, Mandan, North Dakota), U.S. Department of Agriculture, Agricultural Research Service, ARS-NC-20 (Jan. 1975). 8 pp. Reclamation of sodic soils by leaching requires that the leaching solution be high in divalent cations, and that the leaching solution must percolate through the soil profile to transport those cations to the exchange sites. Sodic strip-mine spoil material can be readily reclaimed with solutions of calcium chloride or any other calcium salt that is sufficiently soluble in water, having electrolyte concentrations greater than about 0.5 N. Although the method is shown to be effective, chemical reclamation is costly and is not recommended for large-scale application to strip-mine spoils. (Adapted from authors' Conclusions) CE423

R75-92 MINED LAND RECLAMATION ON THE NORTHERN GREAT PLAINS - INDIAN HEAD MINE

Dudley, T. E. and Becker, J. L. (North American Coal Corp.), Mining Congr. J. 61 (4), 18-23 (1975). This discussion of reclamation in North Dakota considers topography, climate, soil, native vegetation and wildlife, character of spoil materials, and groundwater hydrology. Research on reclamation being carried out in the Northern Great Plains is also discussed. R926

R75-93 VEGETATIONAL RESPONSES BY SUBSTRATE, GRADIENT, AND ASPECT ON A TWELVE ACRE TEST PLOT IN THE BULL MOUNTAINS

Dusek, G. L. (Montana Department of Fish and Game), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 233-246. The revegetation of the Consolidation Coal Company test mine southeast of Roundup, Montana, was monitored for three growing seasons, 1972-1974, to assess the impact of surface mining on wildlife in the area. While vegetation, mostly grasses and forbs, increased on all substrates, the greatest increase was on topsoil. A wildlife survey showed some use by mule deer at all seasons, although the shrubs used in winter by deer on natural areas were virtually absent from the test area. Also included in the paper are climatological data and a map of the test area showing soil characteristics and location of the monitoring stations. 631 M79

R75-94 REVEGETATING BITUMINOUS STRIP-MINE SPOILS WITH MUNICIPAL WASTEWATER: PART I: GRASS AND LEGUME ESTABLISHMENT. PART II: QUALITY OF THE LEACHATE AND SPOIL CHEMICAL CHANGES

Edgerton, B. R., Sopper, W. E., and Kardos, L. T. (The Pennsylvania State University), Part I, Compost Science 16 (4), 20-25 (July-Aug. 1975.) Part II, Compost Science 16 (5), 10-15 (Autumn, 1975). Overburden material used in these tests was taken from very acid spoil removed from over the Lower Kittanning bituminous coal seam in Clearfield County, Pennsylvania. Vegetation studies showed that with sewage treatment grasses grew much better than legumes. Lysimeter tests showed that treatment with sewage sludge and sewage effluent increased pH and nitrate concentrations in spoil leachate and decreased concentrations of sulfate, manganese, iron, aluminum, and boron as the tests continued. The report on which these articles are based has been abstracted at R74-90. CE179

R75-95 COAL SURFACE MINING RECLAMATION COSTS: APPALACHIAN AND MIDWESTERN COAL SUPPLY DISTRICTS

Evans, R. J. and Bitler, J. R., U.S. Bureau of Mines, IC 8695 (1975). 50 pp. This study was conducted to determine the costs of reclamation carried out in conjunction with active mining operations. Reclamation costs were estimated for 20 coal surface-mining operations in three regions of the Appalachian and

R75-95 (continued)

Midwestern Coal Supply Districts. The cost data are presented in terms of dollars per acre, dollars per ton of coal produced, and dollars per cubic yard of overburden moved during backfilling. The reclamation process is divided into three cost categories; premining planning, backfilling, and revegetation. Comparison of reclamation costs by region, by mining method, by slope, and by size of operation shows that the most important cost difference is between area mining methods and contour mining methods. (Authors' abstract adapted) BurM, R1036

R75-96 FALCON COAL PERFECTS MOUNTAIN-TOP MINING WITH GIANT TRACTOR SHOVELS

Can. Mining Met. Bull. 68 (762), 116 (Oct. 1975). The mining and reclamation technique used at Falcon Coal Co. Russell's Branch mine near Hazard, Kentucky, is described. Up to ninety feet of overburden is removed and placed in designated hollows to make large areas of flat land. Jour

R75-97 LAND RECLAMATION AND GOVERNMENT POLICY

Falkie, T. V., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 190-193. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. The author discusses federal programs in mined-land reclamation in the context of the need to use coal as an essential resource of domestic energy. R783, 631 W17p

R75-98 EXPLOITING RHENISH BROWN COAL DEPOSITS IN DEEP OPEN CAST MINES FOLLOWED BY LANDSCAPING AND RECULTIVATION

Gärtner, E., English Advance Papers, Energy Engineering Convention 1975, Lines of Development in Energy Engineering, Düsseldorf, by VDI-Gesellschaft Energietechnik and The Institute of Mechanical Engineers, Steam Plant Group, May 5-7, 1975. pp 255-259. As mining of brown coal advances, villages, roads, railroads, and even rivers, are moved out of its pathway. Displaced people are resettled into new, carefully planned villages. Since there is no attempt to reclaim the mined area exactly as it had been, landscape improvements, including hills and lakes, can be made to give interest and character to an area. The German brown coal mines have been reclaimed for forests, agriculture, and recreation. 621 V48

R75-99 PROBLEMS IN RECLAMATION OF COAL MINE SPOILS IN NEW MEXICO

Gould, W. L., Rai, D., and Wierenga, P. J., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of

R75-99 (continued)

North Dakota, Jan. 20-21, 1975. pp 107-121. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. The geology, climate, soils, and vegetation of the coal fields in the state, especially the largest, the San Juan Basin, are described. Reclamation studies here have included overburden analyses and revegetation research. Limiting factors in revegetating this area are sparse and erratic rainfall and soils unsuitable for plant growth. R783, 631 W17p

R75-100 SELECTED MATERIALS FOR PLANNING THE RECLAMATION OF MINED LAND

Green, J. E. (East Central Intergovernmental Association, Dubuque, Iowa), Council of Planning Librarians, Exchange Bibliography #795 (May 1975). 8 pp. Available, Council of Planning Librarians, P.O. Box 229, Monticello, Illinois 61856 $1.50. This short bibliography has a few general and introductory references, but mainly emphasizes reclamation in Appalachia and the Eastern Interior Coal Field. CE52

R75-101 CHEMISTRY AND EFFECTIVE MINED-LAND RECLAMATION

Grube, W. E., Jr. (1) and Freeman, J. R. (2) [(1) U.S. EPA Crown Mine Drainage Field Site and (2) West Virginia University], 7th Central Regional Meeting, American Chemical Society, Morgantown, West Virginia, May 1975. 4 pp. The chemicals and chemical processes in soils and mine spoils determine the ability of mined land to support vegetation. Chemical factors discussed include plant available nutrients, acidity, toxic elements, and the effects of spoil amendments. R932

R75-102 ILLINOIS LANDS SURFACE MINED FOR COAL

Haynes, R. J. and Klimstra, W. D., Southern Illinois University, Cooperative Wildlife Research Laboratory, prepared with financial support from Illinois Department of Mines and Minerals, Division of Land Reclamation; Southern Illinois University; and Illinois Institute for Environmental Quality, June 1975. 201 pp. Results of the in-depth survey of all lands affected by surface mining in Illinois as of June 30, 1971 are reported. The information compiled covers location, ownership, physical and vegetational characteristics, mining methods and grading that had been carried out, use of the land, and identification of problem areas. R842

R75-103 SOME PROPERTIES OF COAL SPOILBANK AND REFUSE MATERIALS RESULTING FROM SURFACE-MINING COAL IN ILLINOIS

Haynes, R. J. and Klimstra, W. D. (Cooperative Wildlife Research Laboratory, Southern Illinois University), Illinois Institute for Environmental Quality, IIEQ Doc. No. 75-21 (Oct. 1975). 126 pp. NTIS, PB-251 184. This publication reports the results of analyses of 2,084 spoil samples and 22 coal

R75-103 (continued)

refuse samples collected during the 1970-71 survey of surface-mined land in Illinois. Although some surface materials from all mined areas yielded a pH of less than 4.1, most samples had a pH ranging from 5.1 to 8.1. Acid spoils showed properties deleterious to most vegetation. These properties included high exchangeable acidity and soluble salts; possibly toxic concentrations of soluble sulfate, iron, manganese, and aluminum; and low potassium, calcium, and base saturations. (Adapted from authors' Summary) R777

## R75-104 ENVIRONMENTAL FACTORS IN SURFACE MINE RECOVERY

Hill, R. D. and Grim, E. C. (U.S. EPA, Industrial Waste Treatment Research Laboratory, Cincinnati, Ohio), Symposium on Restoration and Recovery of Damaged Ecosystems, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, March 1975. 22 pp. The mining operation is described and the problems of erosion and sedimentation, acid mine drainage, and ion transport are discussed. Environmental control of surface mining starts with preplanning the mining operation, and is concerned with handling the overburden so that material which will support plant growth will be the upper layer of the area to be reclaimed, and with taking advantage of the physical and climatic conditions of the area that will enhance revegetation. R977

## R75-105 MONTANA RECLAMATION PROBLEMS AND REMEDIAL TECHNIQUES

Hodder, R. L., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 90-106. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. The author discusses erosion as one of the problems of mined lands. He suggests and describes several techniques for controlling erosion, such as: reduction of slope gradients, use of mulches or temporary plant covers, and improvement of infiltration rates by surface modification or application of buffer materials. (Adapted from author's Abstract) R783, 631 W17p

## R75-106 ASSESSMENT OF PRACTICALITY OF REMOTE SENSING TECHNIQUES FOR A STUDY OF THE EFFECTS OF STRIP MINING IN ALABAMA

Hughes, T. H., Dillion, A. C.,III, White, J. R., Jr., Drummond, S. E., Jr., and Hooks, W. G., University of Alabama, Department of Geology and Geography, Final Report for the period July 1, 1973 - June 30, 1975 to U.S. National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Contract No. NAS8-29936, Project 1-3-80-0084 (1F) (undated). 175 pp. NTIS, N76-15534. NASA aerial photographs were correlated with field studies of two surface-mined areas in Alabama, the Cordova Area and the Searles Area. Field studies, as well as maps and information from mining companies, determined the areal extent of mining, the status of revegetation and reclamation, amounts of erosion and sedimentation, and extent of mine drainage pollution.

R75-106 (continued)

Recent revegetation efforts cannot be seen in the photographs, but areas with mature trees are hardly recognizable on film as former mined land. Using photographs to show the continuing formation of rills and gullies on slopes allows the estimate of the rate of erosion. The difficulties of relating the appearance of bodies of water to the amount of mine drainage pollution are discussed. CE234

### R75-107 INNOVATIVE EARTHMOVING TOOLS MAKE P&M COAL RECLAMATION PROJECT MORE ECONOMICAL

Coal Age 80 (12), 76-79 (Nov. 1975). This article describes the special dozer blades developed by Pittsburg & Midway Coal Mining Co. for more economical reclamation and their use. Jour, R1041

### R75-108 MONTANA-BASED WES[illegible]ND RESOURCES MINES CROW INDIAN-OWNED COAL AT ABSALOKA M[illegible]

Jackson, D., Coal Age 80 (13), 66-73 (Dec. 1975). Westmoreland's reclamation activity includes premining environmental studies, collecting data from a station installed at the mine, topsoil removal and storage, grading, and revegetation. Jour

### R75-109 EFFECTS OF SURFACE CONFIGURATION IN WATER POLLUTION CONTROL ON SEMIARID SURFACE MINED LANDS

Jensen, I. B. and Hodder, R. L. (Montana State University, Animal & Range Sciences Department), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 325-335. Also presented at American Society of Civil Engineers, Irrigation and Drainage Division Symposium, Logan, Utah, Aug. 11-13, 1975. 10 pp. Studies completed in 1973 after several years of observation showed that precipitation could be trapped by surface manipulation techniques. A large-scale study being carried out at the Rosebud Mine near Colstrip, Montana, the Knife River Coal Mine near Savage, Montana, and the Indianhead Mine near Beulah, North Dakota, will permit evaluation of five treatment methods: gouging on topsoil, chiseling on topsoil, dozer basins on topsoil, chiseling on spoils, and gouging on spoils. The instrumentation for data collection is described. 631 M79, R1032

### R75-110 OPENCAST COAL MINING: LAND RESTORATION

Jones, E. B. (National Coal Board Opencast Executive), Colliery Guardian 223 (6), 209, 211-212, 214, 216 (1975). In Great Britain, surface-mined land reclamation, basically regulated by the code adopted in 1951, is carried out as a long-term project. It takes about five years to return the land

R75-110 (continued)

completely to agricultural use, with narrow shelter belts or small plots forested. The complete restoration process is described in detail. Included in the discussion are planning the mining operation to segregate topsoil and overburden, establishing vegetation on restored land, replacement of farm equipment such as fences, ditches, roadways, and water supplies, and providing drainage systems. Jour

R75-111 OPENPIT MINING IN POLAND AND MAIN PROBLEMS OF ENVIRONMENTAL PROTECTION

Kraus, R. (POLTEGOR), in Environmental Protection of Openpit Coal Mines, Reports of the Polish-U.S. Symposium, sponsored by U.S. EPA and The Central Research and Design Institute for Opencast Mining (POLTEGOR), Wrocław, Poland, Denver, Colorado, May 27-29, 1975. pp 21-28. Published by The University of Denver Research Institute, Denver, Colorado, Sept. 1975. NTIS, PB-249 300. A number of harmful effects of disturbing land surface in all open-pit mining, not just mining for coal, are pointed out and general reclamation activity and requirements in Poland are described. 75-30

R75-112 STRIP MINE REHABILITATION PROBLEMS AND RESEARCH IN WYOMING

Lang, R. L., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 182-189. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. Spoil from strip-mined coal can be successfully reclaimed in Wyoming even in areas where normal annual precipitation averages 20.3 to 25.4 cm (8 to 10 in.). Successful reclamation requires careful analyses of topsoil and spoil cores. Preplanning for proper disposition of problem material, adapted species, proper techniques for planting or seeding and management after revegetation are also essential components in establishing a stable and productive reclaimed area. (Author's abstract) R783, 631 W17p

R75-113 LICHEN ACCUMULATION OF SOME HEAVY METALS FROM ACIDIC SURFACE SUBSTRATES OF COAL MINE ECOSYSTEMS IN SOUTHEASTERN OHIO

Lawrey, J. D. and Rudolph, E. D. (The Ohio State University), The Ohio J. Sci. 75 (3), 113-117 (May 1975). Lichens gathered from a surface-mine area in Perry County, Ohio, and the substrates on which they were found were analyzed. Results showed greater concentration of metals in the lichens than in the corresponding substrates. Values were determined for P, K, Ca, Mg, Mn, Fe, Cu, Zn, Al, and Mo. pH reported for the substrates ranged from 3.3 to 3.7. R872

### R75-114 RECLAMATION OF ORPHAN STRIP MINED LAND IN SOUTHERN ILLINOIS AND WESTERN KENTUCKY: A FIELD STUDY OF THE PALZO PROJECT OF WILLIAMSON COUNTY, ILLINOIS AND THE CLEAR CREEK SWAMP OF WEBSTER AND HOPKINS COUNTIES, KENTUCKY

Leuthart, C. A., Ph.D. Thesis, University of Louisville, 1975. 225 pp. University Microfilms, 75-25,471. The Palzo Project is a 192-acre, surface-mined area which discharges acid drainage. It is being reclaimed by using sewage sludge as a spoil amendment and then revegetating. Water quality in the creek that drains the area was monitored at seven sampling stations by both chemical and biological analyses. Various biological diversity indexes used as indications of pollution are discussed and evaluated and found to be misleading. In Kentucky, the Clear Creek Swamp area has been caused by the filling of stream channels by erosion from farm lands. Some parts of the swamp are affected by acid drainage from mining in the watershed. Both water quality and biota of the swamp were studied. 631 L65

### R75-115 MYCORRHIZAE AND ESTABLISHMENT OF TREES ON STRIP-MINED LAND

Marx, D. H. (U.S. Department of Agriculture, Southeastern Forest Experiment Station), The Ohio J. Sci. 75 (6), 288-297 (Nov. 1975). This paper presents a brief introduction into ecto- and endomycorrhizal associations of plants and discusses their potential value in revegetation. Data from pilot studies on strip-mined coal spoils in Ohio, Virginia, and Kentucky show that pines tailored with Pisolithus ectomycorrhizae prior to planting survive and grow significantly better than trees with other fungal symbionts. The performance of grasses and other herbaceous plants used in revegetation of strip-mined lands may also be improved by use of specific endomycorrhizal fungi. (From author's abstract) R863

### R75-116 COLORADO FIRM PRODUCES THREE MILLION TONS AT 7,000 FEET

Mason, R. H., Coal Mining Process. 12 (11), 38-42 (1975). Water causes problems at this surface coal mining operation in Colorado's Rocky Mountains at 7000 feet plus, where temperatures can dip to 30 to 40 degrees below zero. Two feet of topsoil are removed and stored. After coal removal, overburden and topsoil are replaced. About 2 pounds of alfalfa are planted per acre to restore nitrogen. Rich topsoil requires no fertilizer. Reclaimed land is used mainly for grazing but reforestation is now in experimental stage. Direct seeding has been more effective than aerial methods. Jour

### R75-117 THE MOVEMENT AND OCCURRENCE OF SMALL MAMMALS ON A RECLAMATION PLOT

McCann, S. A. (Montana Department of Fish and Game), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 318-324. Distribution of the 9 species of small mammals found on the 12-acre research area southwest of Roundup, Montana, seemed to depend on the conditions at the site, particularly vegetation

R75-117 (continued)

for cover and for food. The deer mouse was the only species found on mined areas directly after mining. 631 M79

R75-118 LAND RECLAMATION, WATER QUALITY CONTROL, AND ENVIRONMENTAL CONCERN AT CENTRALIA (WASHINGTON) COAL MINE

McCarthy, R. E., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 170-181. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. A program of overburden replacement contouring, water quality control, and vegetation restoration concurrent with coal removal at Centralia, Washington, is discussed, with particular emphasis on turbidity control for clear water discharge under conditions of heavy rainfall, high erodibility, and near colloidal particle suspension. (Author's abstract) R783, 631 W17p

R75-119 SHORT AND LONG TERM FERTILIZER REQUIREMENTS FOR RECLAMATION OF MINE SPOILS AT COLSTRIP, MONTANA

Meyn, R. L., Holechek, J., and Sundberg, E. (Montana State University), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 266-279. Details of geology, soils, climate, and native vegetation are given for the study area at Western Energy Company's Rosebud Mine. Soil analyses showed that compared to agricultural requirements of soils the nutrient levels in the soils of the study area are "low to extremely low for nitrate-nitrogen and phosphorus and adequate to low for potassium." Both the early and the on-going studies described here are aimed at the development of a prescription for the most advantageous application of fertilizer for large-scale reclamation. 631 M79

R75-120 MINING AND RESTORATION HAVE EQUAL IMPORTANCE IN THE UNITED KINGDOM

World Coal 1 (3), 18-20 (May 1975). The article describes several sites mined in South Wales by George Wimpey & Company and returned to grazing and forestry. The company's machinery, used both for mining and for reclamation, undergoes a continuing maintenance program and is moved from site to site as needed. Jour

R75-121 DEVELOPMENT OF A PRE-MINING GEOLOGICAL FRAMEWORK FOR LANDSCAPE DESIGN RECLAMATION IN NORTH DAKOTA

Moran, S. R. (1), Groenewold, G. H. (1), Hemish, L. (2), and Anderson, C. (2) [(1) North Dakota Geological Survey and (2) University of North Dakota], in

R75-121 (continued)

Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 308-316. The development of landscape design is based on an inventory of soils, on the use of physical and chemical characteristics of spoils to define a "reclamation unit," on the hydrology of the area, and on an understanding of the nature of the existing or pre-mining equilibrium in the landscape. These factors and their application to the North Dakota lignite area are discussed. 631 M79

R75-122 NEW BLADES SHAVE LAND RECLAMATION COSTS

The Orange Disc (The Magazine of the Gulf Companies) 22 (2), 24-29 (Nov.-Dec. 1975). New equipment has been developed by Pittsburg & Midway Coal Mining Company for grading mined land in the reclamation process. The giant blades and their operation are described and illustrated. R1013

R75-123 NEW COMPANY FINDS ITS ROAD WORK KNOW-HOW IDEAL FOR SURFACE MINING

Coal Age 80 (13), 78-79 (Dec. 1975). The mining and reclamation carried out by Rural Mining Company, Hurley, Virginia, are described. Road construction techniques, especially in requirements for controlled placement of overburden, are applicable to surface mining. The grasses and legumes used as a mixture for revegetation are listed. Jour

R75-124 NEW TOOLS TESTED TO CUT RECLAMATION COSTS

Coal Age 80 (10), 56, 60 (Sept. 1975). A joint project between the U.S. Bureau of Mines and Pittsburg & Midway Coal Mining Co. involves testing of three special pieces of equipment for reclamation work: "Big Dude," a 40-foot angle blade; the "Veep," a 24-foot vee-plow; and a 30-foot grading bar. A fourth item to be built and tested is a 60-foot variable-angle blade. It is hoped that the new equipment will reduce the reclamation costs by as much as one-half the current rates. Jour

R75-125 KENTUCKY'S PROGRAM FOR IMPROVED SURFACE MINING TECHNOLOGY: ADMINISTRATION AND REDUCTION OF ADVERSE ENVIRONMENTAL IMPACT

Nickel, R. E. (Kentucky Department for Natural Resources and Environmental Protection), in Non-Point Sources of Water Pollution, Proceedings of a Southeastern Regional Conference, Blacksburg, Virginia, by Virginia Water Resources Research Center, P. M. Ashton and R. C. Underwood, Eds., May 1-2, 1975. pp 267-275. Published by Virginia Water Resources Research Center, 225 Norris Hall, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061 (Sept. 1975). The author describes Kentucky's demonstration programs including those on slope stability, revegetation, water pollution control, sediment control, and the determination of the impact of surface

R75-125 (continued)

mining upon land use. 628.2 N81

R75-126 OHIO MINING AND RECLAMATION ASSOCIATION

Mining Congr. J. 61 (8), 41-42 (1975). The Association and its technical assistance to its members are described. Jour

R75-127 OPEN PIT MINERS MOVE RIVER, RESTORE LAND

Engineering News Record 195 (19), 16-17 (Nov. 6, 1975). In the long-range operations of Rheinische Braunkohlwerke, A. G., the coal pit advances steadily, forcing removal of everything in its way. In the reclamation phase, whole communities are relocated to newly built towns, landscape design takes advantage of lakes from coal pits and restores forests, wildlife habitats, and farm lands, while rivers and roadways are relocated. R993

R75-128 MINE SPOIL RECLAMATION RESEARCH AT THE BELLE AYR MINE, NORTHEAST WYOMING

Orr, H. K. (Rocky Mountain Forest and Range Experiment Station), in the Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 304-307. The mining procedure and its effects on the hydrology of the area are described. Several species of trees and shrubs have been planted on a filled area of the mine to study their establishment and adaptability. The physical characteristics of the spoils seem to be suitable for vegetation, and the chemical characteristics did not show any severely adverse factors. The results of plantings in 1973 and 1974 are evaluated as moderately successful, with lack of moisture (precipitation) being the most limiting factor. 631 M79

R75-129 COAL SURFACE MINING IN THE U.S.

Pash, E. A. (U.S. EPA), in Environmental Protection of Openpit Coal Mines, Reports of the Polish-U.S. Symposium, sponsored by U.S. EPA and The Central Research and Design Institute for Opencast Mining (POLTEGOR), Wrocław, Poland, Denver, Colorado, May 27-29, 1975. pp 13-20. Published by The University of Denver Research Institute, Denver, Colorado, Sept. 1975. NTIS, PB-249 300. This review of surface mining in the United States includes the size and extent of the industry in the various producing districts of the country, the development of mining methods, and the state regulations of mining and reclamation. 75-30

R75-130 SURFACE MINING IN PENNSYLVANIA: A STUDY OF THE ENVIRONMENTAL PROBLEMS AND CORRECTIVE MEASURES NEEDED AS A RESULT OF PENNSYLVANIA'S SURFACE MINING OPERATIONS

Peck, Mrs. J. K., Jr. and Preate, E. D., Jr., Meridian Engineering, Inc., Technical Report prepared as a public service for H. E. L. P. (Help Eliminate Life Pollutants), (undated). (25 pp.) This report is focused on the anthracite surface mine areas in northeastern Pennsylvania and describes mining operations in detail. Basic reclamation of land to correct adverse conditions both on and off the mining site and rehabilitation of land to specific end uses are discussed. R979

R75-131 AN EVALUATION OF TREES AND SHRUBS FOR PLANTING SURFACE-MINE SPOILS

Plass, W. T., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service Research Paper NE-317 (1975). Fifty-five trees and shrub species were evaluated on two surface-mine sites in eastern Kentucky. After 4 years' growth, comparison of survival and growth was used to identify the promising species for planting on acid surface-mine spoils. Three species of birch and three Eleagnus species survived and grew well on a range of sites. Noncommercial tree species and shrubs adapted to acid surface-mine spoils included silktree, tree-of-heaven, French tamarisk, Japanese fleeceflower, and Amur privet. (Author's abstract) R875

R75-132 FACTORS RESTRICTING REVEGETATION OF STRIP-MINE SPOILS

Power, J. F., Ries, R. E., Sandoval, F. M., and Willis, W. O. (Agricultural Research Service, U.S. Dept. Agr., Mandan, North Dakota), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 336-346. The physical and chemical characteristics of overburden from a site at the Big Sky Mine, Colstrip, Montana, differ from the characteristics of overburden from a site at Glenharold Mine, Stanton, North Dakota. The spoil characteristics at both places can cause problems for plant growth. Methods to alleviate problems of these spoils include the use of gypsum to counteract high exchangeable sodium, the use of fertilizers where plant-available nitrogen and phosphorus are lacking, and the use of topsoil. 631 M79

R75-133 GROUND WATER IN COAL STRIP-MINE SPOILS, POWDER RIVER BASIN

Rahn, P. H. (South Dakota School of Mines and Technology), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 348-361. In mining areas below the level of the water table, ponds may be formed or aquifers developed in mine spoils after reclamation. Since geological factors as well as methods of handling overburden affect its permeability, both field and laboratory studies are

R75-133 (continued)

being carried out. The quality of waters which may be expected from aquifers in spoils is indicated by a study in which water from 20 sampling stations, including domestic and stock wells and water from spoils, was analyzed. Results show that all waters contained more than the amount of sulfate recommended as the limit in drinking water, and most had high calcium, magnesium, and total dissolved solids. The general conclusion was that spoil waters were not greatly different from natural ground water near mines. 631 M79

R75-134 CHEMICAL AND PHYSICAL PROPERTIES OF SOIL SAMPLES FROM A COAL-BEARING FORMATION IN SAN JUAN COUNTY, NEW MEXICO

Rai, D., Wierenga, P. J., and Gould, W. L., New Mexico State University, Agricultural Experiment Station Research Report 294 (Mar. 1975). 24 pp. Based upon field and laboratory data, five major kinds of soils were recognized in the El Paso Natural Gas Company's lease area. Soil physical, chemical, and mineralogical properties that describe the availability of plant nutrients, presence of toxic elemental concentrations, air and water movement through soil, amount of available soil for stockpiling, ease of digging, accessibility to machinery, and erosional hazard were determined to rate the soils according to their suitability as a topsoil for revegetating the mine spoils. The results clearly showed that two of the types which occupied approximately 60 percent of the study area were better suited for the purpose than the other soils. (From authors' Summary and Conclusions) R1011

R75-135 HYDROLOGICAL IMPACTS ASSOCIATED WITH COAL MINING

Rechard, P. A. (Wyoming Water Resources Research Institute), Mining Congr. J. 61 (8), 70-75 (1975). The author reviews the studies carried out by the Wyoming Water Resources Research Institute on the effects of surface mining on the hydrology of the Eastern Powder River Coal Basin. Several impacts of surface mining on the hydrologic cycle are discussed. A prime necessity is to provide for flood runoff while, if possible, minimizing erosion. The author comments on the controversy over mining alluvial valley floors that "it could be argued that the backfilling process would be similar to the alluvial deposition and that the entire mined-over area would be rehabilitated as an alluvial valley floor." Mining may also cause temporary dewatering of domestic or stock wells fed by an aquifer in the coal seam until the backfill becomes saturated and able to carry the ground water. Therefore, the author points out, that to avoid degrading the quality of the ground water, overburden with soluble contaminents must not be placed where it will be intercepted by the ground water table. Jour

R75-136 RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES IN EASTERN KENTUCKY: REVEGETATION

U.S. Department of Agriculture, Forest Service, Berea, Kentucky, Final Report to U.S. Appalachian Regional Commission and Kentucky Department for Natural

R75-136 (continued)

Resources and Environmental Protection, ARC-71-66-T4 (undated, published January 1975). 324 pp. NTIS, PB-262 494/8WP. In identifying and classifying the coal seams that produce the extremely acid "problem spoils," surveys of mining areas were made and overburden samples were analyzed. Results showed that acid spoils did not occur as widely as had been assumed before the study, and that problems in establishing vegetation could also be caused by lack of plant-available nutrients. A number of greenhouse and field studies of methods of overcoming vegetative failure are reported. Among these methods are use of soil amendments such as fertilizer and lime, seeding and planting procedures including timing and special practices for use on slopes, and species selection. 631 K37

### R75-137 RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES IN EASTERN KENTUCKY: REVEGETATION MANUAL

U.S. Department of Agriculture, Forest Service, Berea, Kentucky, Report to Appalachian Regional Commission and Kentucky Department for Natural Resources and Environmental Protection, ARC-71-66-T4 (undated, published January 1975). 101 pp. NTIS, PB-262 495/5WP. This field manual covers spoil properties that influence vegetation; spoil testing and sampling; vegetation selection and establishment; site preparation and seeding methods; fertilizer and mulch selection and application; and treating acid spoils. The Appendix includes detailed instructions for determination of pH, total exchangeable acidity and phosphorus of spoils; common and Latin names of plants named in the manual; and a selected bibliography. 631 K37

### R75-138 RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES IN EASTERN KENTUCKY. SURFACE MINE POLLUTION ABATEMENT AND LAND USE IMPACT INVESTIGATION: VOLUME I. AN INTRODUCTION TO THE EASTERN KENTUCKY AREA AND ITS DATA CHARACTERISTICS

Eastern Kentucky University, Richmond, Report to Appalachian Regional Commission and Kentucky Department for Natural Resources and Environmental Protection, ARC 71-66-T2 (Aug. 1, 1975). 142 pp. Topics covered relating to the physical characteristics of Eastern Kentucky include geology, topography, climate, water resources, pedology, vegetation, and minerals. A discussion of the population, education, employment, income, housing, and social and economic literature is included in the section relating to the social and economic characteristics of the area. The characteristics of socio-economic, water quality, coal geology, revegetation-reclamation, satellite and aerial imagery, and land use data are discussed, and apparent data deficiencies are presented as a concluding part of this section. Emphasis in the examination of each topic was on its relationship to the mining industry, or to land use and environmental problems. A discussion of the Inventory Map of Surface Mined Lands in Eastern Kentucky is included at the end of this report, although the map is located in Volume V. (From abstract of the report) 631 K37

R75-139 RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES IN EASTERN KENTUCKY. SURFACE MINE POLLUTION ABATEMENT AND LAND USE IMPACT INVESTIGATION: VOLUME III. CONSIDERATIONS OF POST MINING LAND USE, MINE INVENTORY AND ABATEMENT PLAN FOR THE QUICKSAND WATERSHED

Eastern Kentucky University, Richmond, and Mayes, Sudderth, and Etheredge, Inc., Report to Appalachian Regional Commission and Kentucky Department for Natural Resources and Environmental Protection, ARC 71-66-T2 (undated, published 1975). 25 pp. Included in the discussion in this report are considerations of post-mining land use such as demand, location and development cost, and environmental factors such as hydrology, sedimentation, spoil bank stability, haul road abandonment, and the impact of mining on public and mine access roads. The inventory of the 33 surface mines in the watershed includes discussion of the characteristics of each mine, identification of problem areas, and abatement procedures that are recommended on a priority basis. (Adapted from abstract of the report) 631 K37

R75-140 RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES IN EASTERN KENTUCKY. SURFACE MINE POLLUTION ABATEMENT AND LAND USE IMPACT INVESTIGATION: VOLUME IV. AN INVESTIGATION OF ALTERNATIVE DATA SYSTEMS WITH A RECOMMENDATION FOR A STATEWIDE ENVIRONMENTAL STORAGE AND RETRIEVAL SYSTEM

Eastern Kentucky University, Richmond, Report to Appalachian Regional Commission and Kentucky Department for Natural Resources and Environmental Protection, ARC 71-66-T2 (Aug. 1, 1975). 20 pp.+ The objective of this paper is to survey environmental information storage and retrieval systems and to recommend a system. Some of the Federal and state systems were reviewed as well as various alternatives. Also reviewed were vendors and manufacturers' products in the field of automated storage and retrieval, particularly minicomputers and associated peripheral devices. The system proposed is to merge the USGS system with interactive graphics packages. If, however, a completely new system is to be designed by systems planners in the Commonwealth of Kentucky, a summary of questions to be answered and a range of activities to follow are given. (Abstract of the report) 631 K37

R75-141 REHABILITATION RESEARCH AND ITS APPLICATION ON A SURFACE MINED AREA OF EASTERN MONTANA

Richardson, B. Z., Farmer, E. E., Brown, R. W., and Packer, P. E. (Intermountain Forest and Range Experiment Station, U.S. Department of Agriculture), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 247-265. The project was carried out at a level site at the Decker Coal Co. to determine the minimum requirements to achieve establishment of grass, shrubs, and trees, and to evaluate the short- and long-term use of native and introduced grasses and their mixtures. Also evaluated were the feasibility of revegetation methods other than seeding, such as transplanting and sprigging, and the influence on

R75-141 (continued)

establishment of vegetation of various preparations of the seedbed and methods of firming the seed into the seedbed. Both first, 1973, and second, 1974, year results of vegetation are reported in detail. Generally, grass production improved in 1974, with greatest yield from mixtures of native and introduced grasses. At the end of the second year of study, production of grass on fertilized, irrigated and unirrigated, raw spoils and on spoils with topsoil replaced exceeded production of grass on undisturbed range. 631 M79

R75-142 DETERMINE UTILITY OF ERTS-1 TO DETECT AND MONITOR AREA STRIP MINING AND RECLAMATION

Rogers, R. H. (1) and Pettyjohn, W. A. (2) [(1) Bendix and (2) The Ohio State University], Bendix Aerospace Systems Div., Final Rept. to U.S. NASA, Goddard Space Flight Center, BSR 4179 (Feb 1975). (62 pp). NTIS, N75-27515. Computer techniques were applied to process ERTS tapes acquired over coal mining operations in southeastern Ohio on 21 August 1972 and 3 September 1973. ERTS products obtained included geometrically correct map overlays showing stripped earth, partially reclaimed earth, water, and natural vegetation. Computer-generated tables listing the area covered by each land-water category in square kilometers and acres were also produced. By comparing these mapping products, the study demonstrates the capability of ERTS to monitor changes in the extent of stripping, success of reclamation, and the secondary effects of mining on the environment. NASA C-130 photography acquired on 7 September 1973 was compared with ERTS products generated from the 3 September 1973 tape to establish the categorization and geometric accuracy of mapping strip mine activities from ERTS data. (Authors' abstract) R906

R75-143 VACUUMED SOIL AS A SEED SOURCE FOR REVEGETATING STRIP MINE SPOILS

Sauer, R. H. (Battelle Pacific Northwest Laboratories), Mining Congr. J. 61 (9), 16-19 (1975). Native plant seeds were collected by a portable vacuum system on November 12, 1974, when seeds were ripe. The collection area was near the Big Sky Mine of Peabody Coal Company in Montana. Samples taken from litter and from soil broken with a small pick showed that most seeds are in the soil material. Laboratory germination showed a more than adequate supply of mature seeds for revegetation of mined land, but it was recommended that treatment to improve germination be developed. Jour

R75-144 OVERBURDEN TOXICITY OF THE LIGNITE OPENPIT MINES AND METHODS FOR ITS NEUTRALIZATION AS REQUIRED BY THE STACKS RECLAMATION

Skawina, T. (University of Mining and Metallurgy, Krakow, Poland), in Environmental Protection of Openpit Coal Mines, Reports of the Polish-U.S. Symposium, sponsored by U.S. EPA and The Central Research and Design Institute for Opencast Mining (POLTEGOR), Wrocław, Poland, Denver, Colorado, May 27-29, 1975. pp 117-124. Published by The University of Denver Research Institute, Denver, Colorado, Sept. 1975. NTIS, PB-249 300. A classification of toxic

R75-144 (continued)

spoils is presented. The causes of toxicity of soils, the chemistry of toxic spoils, and various materials which can neutralize or inhibit spoil toxicity are discussed. 75-30

R75-145 SLOPE STABILITY RESEARCH STUDY IN THE EASTERN KENTUCKY COAL FIELDS. VOLUME 1. REPORT AND FIELD BOOK. RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES FOR THE EASTERN KENTUCKY COAL FIELDS

L. Robert Kimball, Consulting Engineers, Report to Kentucky Department for Natural Resources and Environmental Protection and the Appalachian Regional Commission, ARC 71-66-T3 (March 1975). 81 pp. NTIS, PB-262 492. The causes of surface mine landslides were investigated by generally evaluating existing slide data for all of the Eastern Coal Fields, carrying out field reconnaissance throughout the area to gather data, monitoring selected representative areas of potential slides, and carrying out laboratory tests of lifted samples to develop parameters for evaluation and analysis of the slide problem. Included in this report is a manual prepared to provide operators and reclamation personnel with a guide to determine areas of potential slides, indicators to detect early beginnings of slides, guidelines for the placement of spoil material to prevent slides, and methods for stabilizing potential and/or active slides. (Summary of the report, adapted) CE308

R75-146 THE COSTS OF COAL SURFACE MINING AND RECLAMATION: A PROCESS ANALYSIS APPROACH

Spore, R. L., Nephew, E. A., Lin, W. W. (Oak Ridge National Laboratory), Western Economic Association 50th Annual Conference, San Diego, California, June 25, 1975. 14 pp. This paper reports on the development of a detailed engineering/economic model of coal production designed to enable an analysis of the short-run impacts of alternative energy policies on coal cost and supply. The model is applied to obtain preliminary estimates of the impact of surface mining regulations on coal production in Appalachia. Some directions for further research also are discussed. (From authors' Introduction) R858

R75-147 COAL MINE RECLAMATION ON THE BLACK MESA AND THE FOUR CORNERS AREAS OF NORTHEASTERN ARIZONA

Thames, J. L. and Verma, T. R., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 48-64. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. The emphasis in this description of the area and of the mining and reclamation carried out there, is on the availability of water for reclamation. Studies to determine the effect of mining on water quality are also reported and show that there

R75-147 (continued)

would not be much movement of water to carry dissolved solids into ground water. Also, dissolved solids in mined-land runoff, while higher than in runoff from unmined lands, are lower than in rivers and wells in the area. R783, 631 W17p

R75-148 TRANSFORM THIS SURFACE MINED LAND INTO THIS RECREATION MECCA

The Consol News, April-May 1975. pp 6-7. The article describes and pictures Friendship Park, Jefferson County, Ohio. R820

R75-149 IMPACTS OF CONTOUR COAL MINING ON STREAMFLOW, A CASE STUDY OF THE NEW RIVER WATERSHED, TENNESSEE

Tung, H.-S., Ph.D. Thesis, University of Tennessee, 1975. 137 pp. University Microfilms, 76-1988. The objective of this study is to determine the quantitative relationships between change in peak and mean daily flow and the associated coal strip mining in a given watershed. The watershed, with a drainage area of 382 square miles, was selected for study because it has been intensively and extensively mined for coal, and long-term hydrological and other related data were available. The Tennessee Valley Authority Daily Streamflow Model was chosen to simulate different watershed conditions in terms of degree of mining disturbance. Four watershed study time periods, representing different accumulated mining disturbance levels and ranging from 0 to 5 percent of the total area disturbed, were selected for analyzing progressive effects of stripping on streamflow. The model has demonstrated that in the early stages of mining, storm runoff has significantly increased; as mining intensified, there was a lesser increase in runoff, which further in creased as the mining increased; and that daily flow increased by 30 percent in a normal water year with the watershed being extensively mined. (From author's abstract) 628.2 T926

R75-150 REHABILITATION OF LAND DISTURBED BY SURFACE MINING COAL IN ARIZONA

Verma, T. R. and Thames, J. L. (University of Arizona, Department of Watershed Management), J. Soil and Water Conservation 30 (3), 129-131 (May-June 1975). The authors summarize reclamation activity carried out on the Black Mesa in cooperation with the Peabody Coal Company. Included in preliminary results are analyses of soils, tabulation of water quality data, and a description of revegetation with native grasses. Grazing was not restricted and prevented satisfactory establishment of vegetation. Jour

R75-151 STRIP MINING AND RECLAMATION ON THE BLACK MESA OF ARIZONA

Verma, T. R., Thames, J. L., and Patten, R. T. (Univ. Ariz., School of Renewable Natural Resources), Proceedings American Society of Civil Engineers,

R75-151 (continued)

Irrigation and Drainage Division Symposium, Logan, Utah, Aug. 11-13, 1975. pp 47-65. The semi-arid Black Mesa area had been thoroughly examined in the two years previous to the presentation of this paper. Details are given on geography, climate, biology, soils, mine operation, hydrology, and on the demonstration projects carried out on land mined by the Peabody Coal Company. Water quality data of runoff from mined and natural surfaces and of a nearby Indian well have been compared to proposed EPA water quality criteria. Water quality of runoff from the mined areas is within the EPA standards and is lower in total salts than water from the Indian well or than typical Arizona irrigation waters. R755

R75-152 THE PROBLEM OF LAND RECLAMATION VIEWED IN A SYSTEMS CONTEXT

Wali, M. K., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, Jan. 20-21, 1975. pp 1-17. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. Development of surface mining for coal in the western United States is discussed in relation to economics, agriculture, legislation, soil forming processes, and needs in revegetation research. R783, 631 W17p

R75-153 AN OVERVIEW OF RECLAMATION IN THE WEST

Wali, M. K. (1), Freeman, P. G. (2), Kollman, A. L. (1), and Johnson, W. (3) [(1) University of North Dakota (2) U.S. ERDA, Grand Forks, ND and (3) U.S. Bureau of Mines, Washington, D.C.], in Technology and Use of Lignite, Proceedings of a Symposium, compiled by W. R. Kube and G. H. Gronhovd, sponsored by U.S. ERDA and the University of North Dakota, Grand Forks, North Dakota, May 14-15, 1975. 371 pp. U.S. ERDA, Technical Information Center, GFERC/IC-75/2 (CONF-750586), pp 294-311. The areas covered are the Rocky Mountain Coal Province, Northern Great Plains Coal Province and the Gulf Coal Province. Features of the mines visited are tabulated and extensive details of climate, native vegetation, spoil materials, methods and costs of reclamation, soils, topography, areas of research in mined-land reclamation, and permit requirements are described. A detailed table summarizes the western states surface mining and land reclamation laws. 662.6 L725

R75-154 REGIONAL SITE FACTORS AND REVEGETATION STUDIES IN WESTERN NORTH DAKOTA

Wali, M. K. and Sandoval, F. M., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 133-153. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. The revegetation potentials of typical sites are discussed in terms of geological, climatic, topographic, and edaphic factors. Data is included for comparison of indigenous vegetation with current land use. Current reclamation research

R75-154 (continued)

for western North Dakota is reviewed. Studies include soil and vegetation chronosequences, overburden characteristics, and plant growth response on spoil material under both growth chamber and field conditions. (From authors' abstract) R783, 631 W17p

R75-155 LAND RECLAMATION IN TEXAS - AN OPPORTUNITY

White, R. L., in Practices and Problems of Land Reclamation in Western North America, M. K. Wali, Ed., Proceedings of a Symposium, Grand Forks, North Dakota, by U.S. Bureau of Mines and University of North Dakota, Jan. 20-21, 1975. pp 154-169. Published by the University of North Dakota Press, Box 8006, University Station, Grand Forks, ND 58202. Climatic and physiographic conditions are favorable for land reclamation in the Piney Woods and Post Oak Savannah areas where commercially important deposits of lignite occur. The land reclamation program of the Texas Utilities Generating Company, with its problems and accomplishments, is described. R783, 631 W17p

R75-156 TREND SURFACE ANALYSIS OF POWDER RIVER BASIN, WYOMING - MONTANA

Yamamoto, T. (Rocky Mountain Forest and Range Experiment Station, U.S. Department of Agriculture), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, W. F. Clark, Ed., Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25-26, 1975. pp 280-288. An analysis of the topography of a region before mining is urged as an aid in planning reclamation of the mined site. Average groundslope isopleths are used to express the regional trend in the study area which includes the central and eastern parts of the Powder River Basin. From the results of the analysis, a dome-shape is suggested for reclamation in the north and a basin-shape for the south. 631 M79

R75-157 OPENPIT MINING OF LIGNITE IN POLAND

Zajac, Z. (Lignite Mines Corporation), in Environmental Protection of Openpit Coal Mines, Reports of the Polish-U.S. Symposium, sponsored by U.S. EPA and The Central Research and Design Institute for Opencast Mining (POLTEGOR), Wrocław, Poland, Denver, Colorado, May 27-29, 1975. pp 3-12. Published by The University of Denver Research Institute, Denver, Colorado, Sept. 1975. NTIS, PB-249 300. The economic statistics of the industry, the geology, hydrology and drainage problems of the Polish lignite deposits, and methods of mining and overburden handling are discussed. 75-30

## 1976

R76-1 RECLAMATION AND REVEGETATION OF STRIP MINED LAND: A SELECTED BIBLIOGRAPHY OF PUBLICATIONS IN THE UNIVERSITY OF MINNESOTA FORESTRY LIBRARY. APPENDIX: A SELECTED BIBLIOGRAPHY ON THE ENVIRONMENTAL EFFECTS OF COPPER-NICKEL MINING IN MINNESOTA

Albrecht, J. and Smith, D., University of Minnesota, Forestry Library, Bibliography series no. 1 (1976). 21 pp. NTIS, PB-268 478. This list of 269 references includes material from as early as 1923. The entries are arranged alphabetically by author. CE492

R76-2 DEMONSTRATION TEST OF TWO IRRIGATION SYSTEMS FOR PLANT ESTABLISHMENT ON COAL MINE SPOILS

Aldon, E. F. (1), Springfield, H. W. (1), and Sowards, W. E. (2) [(1) Rocky Mountain Forest and Range Experiment Station and (2) Utah International, Inc.], in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 201-214. A large-scale field test of two irrigation techniques, sprinkler and drip, installed at the Navajo Mine, New Mexico, is described. Data are presented on spoil characteristics, spoil amendments, seeding mixes, water application rates, and emergence and survival of plants as affected by spoil types, amendments and differing water applications. Emergence and survival after two growing seasons was best on plants receiving the most water, and during July and August the first season. CE449

R76-3 SATELLITE DATA FOR SURFACE-MINE INVENTORY

Anderson, A. T. (1), Schultz, D. (2), Buchman, N. (2), and Nock, M. (3) [(1) NASA/GSFC Code 923 (2) General Electric Company and (3) Maryland Geological Survey], U.S. National Aeronautics and Space Administration, Goddard Space Flight Center, Pre-print X-923-76-199 (Sept. 1976). 13 pp. NTIS, N76-31640. Two digital analysis methods were applied to a case study conducted in Garrett and Allegany Counties, Maryland. The first, a four-band analysis distinguishing various strip-mine-associated classes and conditions, proved useful but has limited extendibility over a seasonal or annual period. In the second approach, a band-ratio method developed to measure disturbed surface areas proved to be extendible both temporally and geographically. This method was used to measure area changes in the region over three time periods from September 1972 through July 1974 and to map the entire two-county area for 1973. For mines ranging between 31 and 244 acres (12 to 98 hectares) the measurement accuracy of total affected acreage was determined to be 92%. Mines of 120 acres (50 hectares) and larger were measured with greater accuracy, some within one percent of the actual area. The ability to identify, classify, and measure strip-mine surfaces in a two-county area (1541 square kilometers--595 square miles) of western Maryland has been demonstrated through the use of computer processing. As a result of this project, a complete mined-land inventory is being incorporated into the State of Maryland mined-land inventory and assessment program. (From authors' abstract) CE233

### R76-4 SATELLITE DATA FOR SURFACE-MINE INVENTORY

Anderson, A. T. (1), Schultz, D. (2), Buchman, N. (2), and Nock, M. (3) [(1) NASA/GSFC, (2) General Electric Company, and (3) Maryland Geological Survey], in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 76-91. This briefly described study, conducted in Garrett and Allegany Counties, Maryland, demonstrated the feasibility of strip mine inventory and monitoring with Landsat multispectral data to within 2 to 3 hectares. Using band-ratioing techniques it was possible to extend signatures over a large geographic area and temporally to other Landsat images within the same orbit. The procedures developed are now being incorporated into a comprehensive State monitoring and inventory program to provide, in a rapid and inexpensive manner, accurate information on the location, size, and condition of areas affected by surface mining. CE439

### R76-5 RECLAIMING STRIP-MINED LAND FOR RECREATIONAL USE IN LACKAWANNA COUNTY, PA. - A DEMONSTRATION PROJECT

Andreuzzi, F. C., U.S. Bureau of Mines, Division of Environment Field Office, Wilkes-Barre, Pennsylvania, IC 8718 (1976). 21 pp. The park's facilities include outdoor recreational activities, picnic grounds, children's play areas, primitive overnight camping, and winter sports. A major attraction is the Anthracite Museum constructed by the Pennsylvania Historical and Museum Commission. (From author's abstract) CE101

### R76-6 RECLAMATION TECHNOLOGY TRAINING IN THE UNITED STATES

Angel, P. N. (University of Kentucky),in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 264-274. Currently in the USA, there are five on-going Associate Degree programs specifically offered in Reclamation Technology. These programs are offered at Belmont Technical College, Lees Junior College, Morehead State University, Madisonville Community College, and Southeast Community College. Information concerning the program, including required curricula, is given for each college. Also included are descriptions of the duties of a reclamation technician and the concept of cooperative education. CE455

### R76-7 REVEGETATION OF LAND DISTURBED BY STRIP MINING OF COAL IN APPALACHIA

Armiger, W. H., Jones, J. N., and Bennett, O. L., U.S. Department of Agriculture, Agricultural Research Service, ARS-NE-71 (Aug. 1976). 38 pp. This report describes field studies which show that surface-mined land in Appalachia can be revegetated. Best results are obtained with spoil amendments for neutralization and fertilization, use of suitable plant species, and planting techniques to favor germination and growth. CE73

R76-8 PRODUCING FORAGES FOR LIVESTOCK ON SURFACE MINED LAND IN SOUTHWEST VIRGINIA

Baker, C. D., Dingus, G. P., and McCart, G. D. (Lonesome Pine Soil & Water Conservation District), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 223-227. Grazing trials with a beef cow and calf herd were conducted in 1973, 1974, and 1975 on land surface mined for coal and reclaimed with Kentucky 31 fescue and sericea lespedeza. Approximately three acres of a vigorous stand of these grasses are required for grazing per beef cow and calf unit. Calves gained an average of 395 pounds each year during the 200 days they were on mine spoil pasture and weaning weights were above state average. CE451

R76-9 SOCIO-ECONOMIC ASPECTS OF SURFACE-MINING: EFFECTS OF STRIP-MINE RECLAMATION PROCEDURES UPON ASSESSED LAND VALUES

Ballou, S. W. (CDM/Limnetics), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 242-263. Specific ecological and economic considerations for several kinds of reclamation procedures were investigated in Mahaska County, Iowa during 1972 through 1974. The procedures evaluated were (1) no reclamation, (2) grading spoils, (3) grading spoils, fertilizing, and replanting, (4) utilizing an abandoned mine for a sanitary land fill after which the land was cultivated, and (5) grading spoils and replacing the original top soil. Pre-mining and post-mining assessed valuation for these sites were evaluated and compared in an attempt to identify the extent of land devaluation following strip mining. (From author's introduction) CE454

R76-10 TWO ATTEMPTS AT LAND RECLAMATION: OVERKILL AND UNDERKILL

Bardwell, R. O. (Gellman Research Associates, Inc.), in Sludge Management Disposal and Utilization, Proceedings of the Third National Conference, Miami Beach, Florida, by ERDA, U.S. EPA, National Science Foundation, and Information Transfer, Inc., Dec. 14-16, 1976. pp 52-53. Copyright by and available from Information Transfer, Inc., 1160 Rockville Pike, Rockville, Maryland 20852 $25. One of the two plans described, neither of which was carried out, was the disposal of sludge from Philadelphia in a strip-mined area in Mahoning County, Ohio. Adverse publicity for the proposal and a public meeting hostile to the project are cited as the result of poor public relations. CE368

R76-11 RECLAMATION OF TOXIC SPOIL STACK FOR VARIOUS SELECTED SOIL CONDITIONS WITH THE TUROW LIGNITE MINE AS AN EXAMPLE

Bauman, K., Central Research and Design Institute for Opencast Mining (POLTEGOR), Wrocław, Poland, Final Report to U.S. Environmental Protection Agency, Special Foreign Currency Program, Project No. 02-532-11, June 30, 1976. 174 pp. The final results of the three-year project confirm the conclusion of

R76-11 (continued)

the November 1974 Interim Report that suitable vegetative species can be grown successfully on acid spoils if neutralizing agents and fertilizers are used. See abstract number R74-109 of this volume. R904a

### R76-12 RECLAMATION OF WORKED-OUT TERRAINS

Bauman, K. (POLTEGOR, Poland), Green Lands 6 (2), 35-37 (Spring 1976). The author describes reclamation of lands in Poland where thick lignite seams are being mined. A diagram illustrates the system of backfilling to assure slope stability and to control water erosion. Spoils are neutralized with lime, fertilized, and planted to grasses on tops of spoil banks and to trees and shrubs on slopes. Jour

### R76-13 REVEGETATION AND USE OF EASTERN SURFACE MINE SPOILS

Bennett, O. L. (1), Armiger, W. H. (1), and Jones, J. N., Jr. (2) [(1) Agricultural Research Service and (2) Virginia Polytechnic Institute], Reprinted from "Land Application of Waste Materials," 1976. pp 195-215. Copyright by and available from Soil Conservation Society of America, Ankeny, Iowa 50021. Revegetation to stabilize slopes and control erosion is a main concern in reclaiming mined land. The authors discuss a number of soil amendments to enhance revegetation. Included are limestone and fertilizers; waste materials such as sewage sludge and fly ash; and mulches such as pulp fiber, grain straw, sawdust, wood chips, chemical binding agents, and mulch crops. Several grasses, legumes, and woody species which have been used successfully in revegetation studies are also discussed. General seeding practices, effects of climate, species selection, erosion control, and vegetation on refuse from mining and preparation plants are summarized. CE330

### R76-14 COAL MINE RECLAMATION - THE COOPERATIVE APPROACH

Blazenko, E. J. and Kuhn, J. A. (Techman Ltd.), Can. Mining Met. Bull. 69 (771), 53-58 (July 1976). Successful reclamation is viewed as the result of planning which takes into account ecological and conservation principles. Implementation of reclamation plans needs cooperation among government agencies, mining industry and consultants. Successful results of some studies of revegetation of alpine and subalpine regions are described. Jour

### R76-15 DESIGN AND EVALUATION OF IMPROVED SURFACE COAL MINE OVERBURDEN HANDLING AND COAL EXTRACTION TECHNIQUES

Callaghan, D. J., Bowersmith, J. A., Marshall, L. C., Bennett, D. A., and Nickey, R. A., Theodore Barry & Associates, Report to U.S. Bureau of Mines, Office of Assistant Director--Mining, DOI/DF-77/004b, Open File Report 35-77 (July 22, 1976). 174 pp. NTIS, PB-264 764. The four mining systems described in detail and evaluated are terrace pit mining, area haulback mining,

R76-15 (continued)

periphery mining, and tower excavator mining. These systems were each carefully analyzed both with regard to methods and equipment alternates. A model mine was then designed and estimated to provide detailed cost and production data. Then an analysis was made of the engineering feasibility, the implementation requirements, the environmental benefits, the financial implications and the limitations of each mining system. An objective comparison of relative merit by each category showed that the terrace pit was the best system around which to design a field demonstration program. Its advantages included the estimation that it could be a more economical and environmentally responsive way to mine western coal reserves and had much less delay time for equipment delivery. The report also includes brief consideration of ten additional mining methods and techniques, and of common reclamation problems. Reclamation laws and regulations of 16 states are abstracted. The bibliography has 69 references. (Adapted from authors' abstract and Executive Summary) 320. 76-4

R76-16 RECLAMATION, RESEARCH & DEVELOPMENT IN MOUNTAINOUS REGIONS

Cherene, L. J. (Kaiser Resources Ltd.), in Third International Conference on Coal Research Preprints, Sidney, Australia, Oct. 6-8, 1976. Paper D.2 6 pp. The revegetation research program being carried out by Kaiser Resources Ltd. in the Elk River Coal Field, British Columbia, is described. 662.6 I61

R76-17 CROSS-RIDGE MINING OF MOUNTAINTOPS: A BETTER TECHNIQUE FOR APPALACHIA?

Chironis, N. P., Coal Age 81 (12), 74-78 (1976). The development of the method by Ford, Bacon & Davis and its refinement by Skelly and Loy in cooperation with the West Virginia Surface Mining and Reclamation Association is described. It is pointed out that the cross-ridge technique will use computer-assisted planning to minimize spoil stowed in head-of-hollows and on ridges and will maximize the amount of spoil used in reclaiming the flat mountain tops. This technique has an economic advantage in multiple-seam mining. Jour

R76-18 RIGOROUS VOLUMETRIC COMPUTATIONS USING CORE BORINGS & CROSS SECTION DATA

Coe, D. A. (Photogrammetric Services, Inc.), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 54-63. The system which is proposed in this paper uses cross sections and core boring data, however, it relates all data into several formulas used to represent the seam surface, while interlocking all values at once. The method, although it can use data obtained from surveying methods, is geared and adapted for use in the photogrammetric field. (From author's introduction) CE437

R76-19 VISUAL DESIGN RESOURCES FOR SURFACE-MINE RECLAMATION

Cole, N. F., Ferraro, M., Mallary, R., Palmer, J. F., and Zube, E. H., University of Massachusetts, Institute for Man and Environment and ARSTECNICA, National Endowment for the Arts Grant No. R50-42-86, IME Publication No. R-76-15 (Aug. 1976). 131 pp. In this study of the reclamation of surface mining from the perspective of aesthetics, a computer-graphic program, ECOSITE, was developed as a landform design tool to aid in the preplanning and improvement of reclamation aesthetics. It was demonstrated that the program has potential for studying and displaying original landform design compositions, simulating natural landforms, and providing three dimensional graphical information needed to construct relief models of landform compositions. Moreover, given the needed coordinate information, the program can be used to replicate and model existing topography. An additional accomplishment was the design of a vacuum table consisting of a vacuum pump, plenum and table, framed rubber blanket and a collection of plaster form elements. This system made it possible to rapidly investigate and illustrate a broad array of design syntatic concepts relative to relief sculpture and landform design. (From authors' Summary of Findings) CE217

R76-20 COLORADO ADOPTS BROAD LAW REGULATING MINE RECLAMATION

Coal Age 81 (7), 23 (1976). Legislation to regulate coal and other mining reclamation in Colorado went into effect July 1, 1976. Eighteen requirements are spelled out. Jour, R1037

R76-21 CONSOL 'REAPS' BENEFITS OF GOOD RECLAMATION

The Consol News, Dec.-Jan. 1975-1976. p 7. The yield of wheat harvested from reclaimed land at the Glenharold Mine near Stanton, North Dakota, is estimated to be about 83 percent of the yield from unmined land in the area. Jour

R76-22 CONSOLIDATION COAL CO. - 1975 FALL HARVEST OF SPRING WHEAT

Mining Congr. J. 62 (1), 11 (1976). Harvest from reclaimed land at Glenharold mine in North Dakota showed that two years after mining, mined land could yield approximately 83 percent of the harvest expected from unmined land. Jour

R76-23 RECLAIMING MINED LANDS IN ALASKA

Conwell, C. N., Trans. AIME 260, 81-84 (1976). Also presented at AIME-SME Fall Meeting, Salt Lake City, Utah, Sept. 10-12, 1975. 7 pp. Preprint No. 75-AO-304. Successful reclamation of coal-mined lands in Alaska has been demonstrated in test areas. The state's legal requirements for reclamation are summarized. Jour, AIME

R76-24 EVALUATION OF CURRENT SURFACE COAL MINING OVERBURDEN HANDLING TECHNIQUES AND RECLAMATION PRACTICES

Cook, F. and Kelly, W., Mathematica, Inc., Mathtech Division, Final Report to U.S. Bureau of Mines, Open File Report 28-77 (Dec. 24, 1976). 318 pp. NTIS, PB-264 111. In this two-year study, an evaluation of mining and reclamation practices at 159 randomly sampled surface coal mines in the United States was conducted. It is concluded that reclamation practices in most of the 22 coal-producing states were adequate during 1975, but that improvement in reclamation performance was desirable in the acid area of the central U.S. and in mountainous southwestern Virginia. Productivity improvements should result from research to determine efficient or optimal operating procedures for dragline stripping of single and multiple seams, surface mining of lignite, multicut and multiseam haulback mining on steep slopes, mountaintop removal, and surface mining in swampy or deeply glaciated areas. Specific candidate research projects are discussed in this report. (Authors' abstract) CE266

R76-25 STRIP MINING AND THE MANAGEMENT OF HIGH QUALITY WATERS IN PENNSYLVANIA: AN ALTERNATIVE APPROACH

Curry, W. J., III, Laurel Highlands Conservation and Development Project, Discussion Paper No. 1 (1976). 34 pp. Available from the Project at 532 Goucher Street, Johnstown, Pennsylvania 15905 $1.50. Part of the ruling in the appeal of Doraville Enterprises on the refusal of an application to operate a strip mine in the Laurel Hill Creek watershed was that the Pennsylvania Department of Environmental Resources "could not apply a blanket policy banning surface mining from watersheds designated as conservation areas." The author agrees with this position and advocates a policy of case-by-case review of applications for strip mining, as well as other developments in conservation areas, with the burden of rigorous proof on the developer to show that there will be no environmental degradation. It is also recommended that costs for baseline studies, continuous monitoring, and application review should also be borne by the applicant. R849

R76-26 ANNOTATED BIBLIOGRAPHY ON THE ECOLOGY AND RECLAMATION OF DRASTICALLY DISTURBED AREAS

Czapowskyj, M. M., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service General Technical Report NE-21 (1976). 98 pp. The 591 entries, listed alphabetically by author, cover land disturbance by all surface mining including coal, as well as other surface effects of mining and resource use such as coal refuse piles and fuel ash disposal. Each entry is annotated and coded to show geographic area, material mined, and general focus of the paper such as spoil characteristics, type of environmental pollution or reclamation and land uses. There are an author index and indexes of material assigned to the various code categories. CE147

R76-27 JONES & BRAGUE HAS BEEN RECOGNIZED FOR EXCELLENCE OF ITS RECLAMATION

Davis, H., Coal Age 81 (12), 94-97 (1976). The mining method, overburden handling, and grading and seeding immediately after mining at the company's mines in Tioga County, Pennsylvania, are described. Jour

R76-28 DEVELOPMENT OF PRE-MINING AND RECLAMATION PLAN RATIONALE FOR SURFACE COAL MINES

Dames & Moore, Report to U.S. Bureau of Mines (June 1976). NTIS, PB-258 041SET. Vol. I. THE RATIONALE FOR DATA ACQUISITION Open File Report 100 (1)-76, 136 pp. NTIS, PB-258 042. Vol. II. METHODS OF DATA ACQUISITION Open File Report 100(2)-76, 148 pp. NTIS, PB-258 043. Vol. III. LEGAL CONTROLS OF SURFACE MINING Open File Report 100(3)-76, 209 pp. NTIS PB-258 044. In Volume I, the essence of the rationale is shown to be the employment of necessary skills at the proper time to evaluate specific data requirements and integrate them into a cost-effective program to produce initial and major feasibility reports, mining and reclamation plans, and the environmental impact assessment. Volume II is a general guide to the selection of cost-effective methods of site data acquisition in all geologic, environmental, and socio-political circumstances. The objective of Volume III is to provide a concise review of six major types of legal constraints, controls, and regulations on surface coal mining in the United States, as of January 1976. At the same time, an attempt is made to format the details of Federal and State exploration, mining, and reclamation regulations such that point-by-point comparisons can be made and updated as revisions occur. (From abstracts of Volumes I, II, and III) 631 D15

R76-29 FEASIBILITY STUDY: FLY ASH RECLAMATION OF SURFACE MINES, HILLMAN STATE PARK

Dougherty, M. T. and Holzen, H. H., Ackenheil & Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-183 (Aug. 1976). 71 pp. NTIS, PB-258 485. The study was performed to determine the technical and economic aspects of surface treatment of regraded acidic strip mine spoils with pulverized fuel fly ash as a method to produce a soil cover which will sustain grasses and legumes and also enhance abatement of mine drainage. Data on present stream water quality of Hillman State Park were obtained to establish a set of parameters which will be used for comparison with future water quality analysis in order to determine effects of construction and the application of fly ash. Other criteria used in this evaluation include: pH of strip mine spoil material and fly ash; moisture retention characteristics of spoils and spoils treated with fly ash; and grain size distribution of spoils treated with fly ash. Results indicate this demonstration project would be technically feasible and the reclamation would produce useable land and improve water quality. (From authors' abstract) CE109

## R76-30 STRIP MINING OF COAL - ENVIRONMENTAL SOLUTIONS

Doyle, W. S., Park Ridge, New Jersey: Noyes Data Corporation, 1976. 352 pp. All except one of the 19 government documents on which this book is based have been abstracted in the Coal and Environment Series. Erosion and sedimentation, acid mine drainage and its effects, spoil characteristics, revegetation and spoil amendment studies, and reclamation practices in Germany are among the subjects discussed. 622 D75 1976

## R76-31 SOIL MECHANICS TESTS ON COAL MINE SPOILS

Drnevich, V. P. (1), Williams, G. P. (2), and Ebelhar, R. J. (1) [(1) University of Kentucky and (2) Northeastern Forest Experiment Station, Berea, Kentucky], in Proceedings of the Second Kentucky Coal Refuse Disposal and Utilization Seminar, University of Kentucky, Institute for Mining and Minerals Research, IMMR21-PD15-76 (September 1976). pp 47-59. The paper includes discussion of some characteristics that affect the stability of mine spoil dumps; of characteristics that are important to the rate at which waters seep through mine spoil fills, and to the extent fills constructed of mine spoil will settle; and of soil mechanics tests that are useful in measuring those characteristics. The results on several actual mine spoil materials from the eastern Kentucky coal field are presented. Some simple, easy to perform tests that indicate the results of the more complicated tests are identified, and examples of how to apply the results of soil mechanics tests to practical problems of mine spoil disposal are presented. (From authors' Introduction) 631 K3

## R76-32 STRIP MINE RESTORATION THROUGH SOLID WASTE DISPOSAL - MULTIPLE BENEFITS AND ECONOMIC INCENTIVES

Earl, T. A. (Todd Giddings and Associates), Trans. AIME 260, 125-128 (1976). Also presented at AIME-SME Fall Meeting, Salt Lake City, Utah, Sept. 10-12, 1975. 14 pp. Preprint No. 75-F-334. Hydrogeology and spoil characteristics, especially amount of carbon, can both determine whether a mined area is suitable for disposal of solid municipal and industrial waste. An economic benefit is the sharing of costs of land fills and mined-land reclamation. Examples of operating, completed, and planned refuse disposal sites are given. Jour, AIME-SME

## R76-33 MOSAIC/PHOTOMONTAGE: A NEW CONCEPT TO HELP RECLAMATION PLANNING

Entzminger, R. A. (U.S. Forest Service), Coal Mining Process. 13 (6), 76-78 (1976). The system produces a computer-drawn overlay of proposed land changes on a baseline photograph of the area. It can show surface mine cuts and reclamation as well as the structures relating to mining, processing and power generation. R1029

R76-34 EQUIPMENT UTILIZATION KEYS MINING SUCCESS

Green Lands 6 (4), 18-19 (Winter 1976). A mining operation of the Buffalo Coal Company in Logan County, West Virginia, uses the valley-fill method of reclamation and will create 583 acres of level land. An excavator that could handle oversized rock was used to move the overburden. Jour

R76-35 EXPERIMENTAL GARDEN THRIVES ON MINE SITE

Green Lands 6 (4), 6-8 (Winter 1976). Squash, corn, beans, tomatoes and potatoes have been grown by agronomist Nick Jones on a bench created by a surface mine of the Raleigh Empire Coal Company in 1969. The garden, on White Oak Mountain near Beckley, West Virginia, has demonstrated that "marketable vegetation can be successfully produced on mine spoils." Jour

R76-36 HYDROLOGIC AND SOIL PROPERTIES OF COAL MINE OVERBURDEN PILES IN SOUTHEASTERN MONTANA

Farmer, E. E. and Richardson, B. Z. (Intermountain Forest and Range Experiment Station, U.S. Department of Agriculture), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 120-130. This research was conducted at the Decker Mine on the infiltration and erosion rates of bare overburden piles. The influence of several soil variables including spoil porosity, soil crust strength, and overburden chemical and physical properties on these hydrologic characteristics was examined. It was concluded that grading dragline overburden piles to their final figuration as soon as feasible not only increases the infiltration rate but also decreases soil erosion potentials. CE442

R76-37 LEGISLATIVE REGULATION OF THE ENVIRONMENTAL IMPACT OF STRIP-MINING

Fay, G. and Glenn-Lewin, D. C., Iowa State University, Energy and Mineral Resources Research Institute, IS-ICP-17 (May 1976). 38 pp. The Federal "Surface Mining Control and Reclamation Act of 1975" which was vetoed is compared to mining regulations in force in Pennsylvania, West Virginia, Kentucky, Ohio, Illinois, Missouri, Kansas, Iowa, North Dakota, Wyoming, and Montana. ISU

R76-38 SIMULATION OF HYDROLOGIC PROCESSES FOR SURFACE MINED LANDS

Fischer, J. N., Ph.D. Thesis, University of Arizona, 1976. 122 pp. University Microfilms, HEF 77-06051. The initial phase of the procedure is the development of a sequence-based stochastic precipitation model which provides as output simulated sequences of annual precipitation events. Probability distributions for storm parameters such as precipitation per event, event duration, distribution of events in time, etc., are obtained from analysis of historic climatological data for the study area. From these distributions,

R76-38 (continued)

simulated series of annual events possessing statistical characteristics of the actual event sequences are generated. Statistical analysis shows no significant differences between parameters of the actual events and those generated by the model. The stochastic precipitation model is used to drive a deterministic model simulating other hydrologic processes. In the second model, a finite difference solution records changes in water content within the soil profile. Root extraction, evaporation, infiltration and percolation are also simulated based upon changing hydraulic head at selected depth intervals. The kinematic wave approximation and the continuity of mass equation are used to route overland flow from the watershed. The model accurately predicts the distribution of water resulting from annual series of precipitation and potential evapotranspiration event sequences. (From author's abstract) 628.2 F529

R76-39 FORDING'S DUAL OPERATIONS ARE UNIQUE IN CANADA

Fish, R., Canadian Mining J. 97 (11), 42-49 (1976). The operations of Fording Coal Ltd. in two neighboring pits in the Rocky Mountains of British Columbia are described. It is noted that reclamation research is in progress on vegetation for leveled spoils at high altitudes. CE359

R76-40 IMPACT OF HIGHER ECOLOGICAL COSTS AND BENEFITS ON SURFACE MINING

Foreman, W. E. (Virginia Polytechnic Institute and State University), American Mining Congress Coal Show, Detroit, Michigan, May 10-13, 1976. Session Papers Set No. 4. 16 pp. This paper summarizes the author's Bureau of Mines Open File Report of the same name and describes the development and validation of the mathematical model for determining costs of reclamation. 662.6 A665

R76-41 BIBLIOGRAPHY OF STRIP MINE ECOLOGY

Glenn-Lewin, D. C., Fay, G., and Cecil, S. D., Iowa State University, Energy and Mineral Resources Research Institute, IS-ICP-20 (May 1976). 47 pp. This list of references is arranged in six major categories with duplicate entries where appropriate. The categories are Bacteria, Terrestrial Environment, Aquatic, Reclamation, General, and Bibliographies. ISU

R76-42 VERTEBRATES (EXCLUDING FISH) IN THE COAL STRIP-MINING REGION OF SOUTHEAST IOWA

Glenn-Lewin, D. C. and Voight, J., Iowa State University, Energy and Mineral Resources Research Institute, IS-ICP-34 (Oct. 1976). 36 pp. The purposes of this report are 1) to provide a list of vertebrate species (other than fish) in the southeast Iowa region so that future environmental impact studies will

R76-42 (continued)

have available baseline qualitative information for site studies, and 2) to survey the abundance and distribution of the vertebrates. The data were obtained from extensive field observations, quantitative sampling for some species, and from the literature. Mammals, birds, amphibians, and reptiles are tabulated separately. For each species, the tables list both accepted common and scientific names, habitat, regional range, regional abundance, and range in the United States. For birds, residence-migrant status is also listed. (Adapted from authors' Introduction) ICP

R76-43 USE OF SURFACE MINED LANDS

Glover, F. W., Jr. (USDA Soil Conservation Service), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 236-241. Four examples of use of surface mined land in West Virginia are described. These include maintenance of cow herds for production of feeder cattle and a feedlot operation, use of a mined area for a rifle and pistol range and National Guard bivouac area, pasturing and hay production, and an area that has the potential to be used as a housing development, shopping center, or an industrial site. In addition, 86 alternative uses of reclaimed surface mines in West Virginia are listed. CE453

R76-44 USE OF SEWAGE SLUDGE FOR LAND RECLAMATION: A COAL COMPANY'S POINT OF VIEW

Grandt, A. F. (Peabody Coal Company), in Sludge Management Disposal and Utilization, Proceedings of the Third National Conference, Miami Beach, Florida, by ERDA, U.S. EPA, National Science Foundation, and Information Transfer, Inc., Dec. 14-16, 1976. pp 46-49. Copyright by and available from Information Transfer, Inc., 1160 Rockville Pike, Rockville, Maryland 20852 $25. The attempts of Peabody Coal Company to study the effects of sewage sludge disposal on their mined land are summarized. A project was carried out at the Palzo site, but other projects were either abandoned because of public objection or were not carried out because permits for treating runoff from the project were not granted. CE368

R76-45 GRUNDY COUNTY DEMONSTRATION SITE PHASE II: PROGRESS REPORT FOR 1975-1976

Green, B. B. and Zellmer, S. D., Argonne National Laboratory, Report to Illinois Institute for Environmental Quality, IIEQ Project #80-027, June 1976. 16 pp. On an abandoned mine adjacent to Goose Lake Prairie State Park, half-acre sites were treated with scrubber sludge, topsoil, sludge, and lime on flat areas, and with chemical stabilizer, sludge, and straw mulch on slopes. Both slopes and flat areas had control sites. All sites were gouged, treated, and seeded. Results showed that straw mulch was significantly more effective than other treatments on the slopes, while none of the treatments of the flat

R76-45 (continued)

areas were significantly more effective than the control. CE127

R76-46 TOOLS FOR COAL MINE RECLAMATION - WHAT ARE THE PRACTICAL OPTIONS?

Haley, W. A. and Miller, R. C. (Caterpillar Tractor Co.), AIME Annual Meeting, Las Vegas, Nevada, February 22-26, 1976. 18 pp. Preprint No. 76-F-56. Overburden handling and topsoil reclamation are considered as separate parts of the reclamation process. Since no single machine is best in all situations, the authors evaluate the capabilities of scraper systems and truck-loader combinations. The costs of handling overburden and topsoil are discussed and it is emphasized that the most economical system has the least rehandling of spoil and topsoil. AIME

R76-47 THE POTENTIAL FOR USING SEWAGE SLUDGES AND COMPOST IN MINE RECLAMATION

Hill, R. D. and Montague, A. (U.S. EPA), in Sludge Management Disposal and Utilization, Proceedings of the Third National Conference, Miami Beach, Florida, by ERDA, U.S. EPA, National Science Foundation, and Information Transfer, Inc., Dec. 14-16, 1976. pp 39-45. Copyright by and available from Information Transfer, Inc., 1160 Rockville Pike, Rockville, Maryland 20852 $25. In a study by the Forest Service and the Metropolitan Sanitary District of Greater Chicago, sewage sludge was applied at the Palzo site in southern Illinois at three different rates, with one area designated as control. Results show that sludge increased the pH of the soil; that uptake of elements by weeping lovegrass was not enough to be toxic; and that runoff from the treated area was less acid, had less iron, aluminum, manganese, copper, and sulfate, and more cadmium, chromium, and zinc than before treatment. Sociological as well as technical problems of sewage disposal on mined land are discussed. CE368

R76-48 CONSERVATION TECHNICAL ASSISTANCE TO SUPPORT DEVELOPMENT OF ENERGY RESOURCES WITH MINIMUM ENVIRONMENTAL DEGRADATION

Holmberg, G. V. (U.S. Department of Agriculture), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 44-53. Program RECLAM, the USDA Program for Reclamation of Lands Affected by Mining, has been established by the Secretary of Agriculture as a cooperative effort of a number of organizations in the Department of Agriculture. The technical assistance of the Soil Conservation Service includes planning to reestablish topsoil and developing diverse plant materials for revegetating reclaimed lands in all parts of the United States. CE436

### R76-49 A REVIEW OF SELECTED LAWS AND GOVERNMENTAL PROGRAMS IN COLORADO, AS RELATED TO MINERAL RESOURCE MANAGEMENT AND SURFACE MINING

Imhoff, E. A., U.S. Geological Survey, Resource and Land Investigations (RALI) Program, Open-file report no. 76-649 (1976). 47 pp. The review is based on interviews with governmental planners, analysis of statutes and technical reports, and field visitations in Colorado. State, regional and local activities were considered. State programs found to affect surface mining in Colorado are based primarily on: the mineral resources planning provisions of Title 34-1-304, CRS, 1973; the critical areas law set forth in House Bill 1041 of 1974; and the mined-land reclamation act of 1976. Each of the Colorado state programs is shown to rely on local initiative in setting objectives, in resource and related land planning, and in plan implementation through local law enforcement. With the exception of mine reclamation (which is regulatory) the state program activities which were reviewed consisted largely of technical assistance, coordination, and proprietary functions. Attention is focussed on a City of Boulder ordinance which formalizes cooperation between a mining company, The City, a state land trust, and (by implication) a federal agency in such a way that objectives of each cooperator are to be served as a 315 acre site is converted from present farmland, into a mine, and--ultimately--into a public open space and regional park. (From author's abstract) CE142

### R76-50 STATUS AND CONTENT OF STATE MINED-AREA RECLAMATION PROGRAMS

Imhoff, E. A. (U.S. Geological Survey), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 92-105. This report is based on two surveys of state mined-areas reclamation programs conducted during August-September, 1975 and April-June, 1976. Information for 34 states is provided in table form on Title of Acts, Conserving and Replacing Topsoil, Backfilling and Grading, Reducing Highwall or Pitwall, and Revegetating for Beneficial Use. CE440

### R76-51 A GUIDE TO STATE PROGRAMS FOR THE RECLAMATION OF SURFACE MINED AREAS

Imhoff, E. A., Friz, T. O., and LaFevers, J. R., U.S. Geological Survey, Circular 731 (1976). 33 pp. This report compiles the status and content of reclamation programs as of 1975. A directory of state sources of information is also included. R1020

### R76-52 LAND AND NATURAL RESOURCE INFORMATION AND SOME POTENTIAL ENVIRONMENTAL EFFECTS OF SURFACE MINING OF COAL IN THE GILLETTE AREA, WYOMING

Keefer, W. R. and Hadley, R. F., U.S. Geological Survey, Circular 743 (1976). 27 pp. Available, Branch of Distribution, Eastern Region, U.S. Geological Survey, 604 South Pickett Street, Alexandria, VA 22304. The principal

R76-52 (continued)

deposit in Campbell County, along the east margin of the Powder River Basin in northeastern Wyoming is the Wyodak-Anderson coal bed. An integrated program of geologic, hydrologic, geochemical and related studies by the U.S. Geological Survey in the area provides basic information about the land and its resources, including characteristics of the landscape; properties of rocks and surface materials; depth and thickness of coal; streamflow; depth to ground water; quality of ground water; sediment yield; concentrations of trace elements in soils, rocks, coal, vegetation, and water; and current land use. The data are used to analyze and predict some of the potential environmental effects of surface mining such as the extent of land disturbance, nature and degree of landscape modification, and disruption of surface-water and ground-water systems. (From authors' abstract) US Geol

R76-53 OPTIMIZATION OF RUNOFF AGRICULTURE ON RECLAIMED MINE LANDS

Kelly, J. L., M.S. Thesis, Univ. Arizona, 1976. 87 pp. Optimization of runoff agriculture involves the selection of a crop whose water requirements correspond to the precipitation patterns of the area; the selection of a runoff treatment which, when applied to the catchment area, produces the greatest amount of water at the lowest cost; and the establishment of the ratio of catchment area to crop area. A model to select the best suited crop and runoff treatment for the system being considered is presented and is modified to determine the optimum catchment area ratio to be used. The model was applied to the reclaimed coal mine lands on the Black Mesa of northern Arizona. Results show that maximum economic returns can be obtained for conventional irrigated agriculture by using a ratio of 55 acres of catchment area with no runoff treatment to one acre of cropland producing corn. The use of carry-over pond storage to allow for supplemental irrigation is prohibited due to high evaporation rates on the Black Mesa. By reducing the corn crop density from the conventional 20,000 plants per acre to 5,000 plants per acre, a density used by the Hopi Indian farmers for cultivating a highly adapted strain of corn, the catchment area ratio can be reduced to an apparent ratio of 13:1. (From author's abstract) Univ. Ariz. Lib. E9791 1976 477

R76-54 A REPORT ON ANTHRACITE OPEN PIT MINING - A FEASIBILITY STUDY - PART IV ENVIRONMENTAL RECLAMATION: REPORT EXHIBIT NO. 4

Knight, C. G. and Gatrell, N. (Department of Geography), The Pennsylvania State University, Coal Research Section, Special Research Report to Pennsylvania Science and Engineering Foundation, SR-106 (May 1, 1976). 107 pp. This report presents a justification for concurrently removing remaining coal by pit mining and reclaiming newly mined land. Abatement of air and water pollution, prevention of subsidence, and restoration of devastated land are all included in the study. There are 245 references. 662.6 P4

### R76-55 AN EVALUATION OF SURFACE-MINE SPOILS AREA RESTORATION IN WYOMING USING RAINFALL SIMULATION

Lusby, G. C. (1) and Toy, T. J. (2) [(1) U.S. Geological Survey and (2) University of Denver], Earth Surface Processes 1, 375-386 (1976). A recently developed rainfall simulator was used to apply 'rainstorms' on restored spoils areas at two coal mining sites in Wyoming. Runoff and sediment yield were considerably greater from the reworked areas compared to similar measurements on nearby undisturbed areas. This may possibly be attributed to the fact that in the disturbed areas mean slopes were generally greater, there was more clay at the surface, and concentration of roots was not as great as in the undisturbed areas. The rainfall simulator appears to be a valuable tool in determining baseline data for later comparison with data from areas under rehabilitation. (Authors' Summary) CE268

### R76-56 SOME VEGETATION AND SOIL CHARACTERISTICS OF COAL SURFACE MINES IN ALABAMA

Lyle, E. S., Jr., Janes, D. J., Hicks, D. R., and Weingartner, D. H. (Alabama Agricultural Experiment Station, Auburn University), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 140-152. Six unreclaimed randomly-selected mines that had been abandoned longer than 13 years were studied to develop quantitative information regarding soil material and vegetation found on abandoned coal surface mines in Alabama. The average tree age, timber volume per acre, overstory and understory species, and soil samples were inventoried for each site. The timber volumes found on these abandoned mines would not be considered low on unmined but unmanaged forest land and softwood volumes on the mines were higher than the area average. CE444

### R76-57 THE AESTHETICS OF SURFACE-MINE RECLAMATION: AN ON-SITE SURVEY IN APPALACHIA 1975-1976

Mallary, R. and Carlozzi, C. A., University of Massachusetts, Institute for Man and Environment and ARSTECNICA, Publication No. R-76-5 (April 1976). 39 pp.+ The survey, which included stops in Kentucky, Pennsylvania, and Ohio, was carried out mainly in West Virginia. Current reclamation practices and the progress achieved beyond early reclamation activities are reviewed. The authors emphasize the fact that while mining personnel were in favor of reclamation and many were interested in research to improve current practices, few perceived of reclamation as a "recomposed landscape" with all components as "part of a unified and integrated scheme that harmonizes with the surrounding environment while also reflecting and expressing the function or after-use of the site." There is a discussion of the concept of "reclamation to approximate original contour" and its validity in various contexts. One of the appendixes has comments on the aesthetics of reclamation at a number of the sites visited during the 1975 West Virginia Interagency Evaluation Tour. CE220

### R76-58 ABANDONED MINE AREAS CAN BE VALUABLE ASSETS

Maneval, D. R. (Appalachian Regional Commission), Coal Mining Process. 13 (8), 52-56 (1976). Two case histories of reclamation of mined lands to industrial parks are representative of the activities of the Appalachian Regional Commission. The sites are in Delano, Pennsylvania and Coshocton, Ohio. The settings of the projects, socioeconomic factors, and land use planning are discussed. CE81 Jour

### R76-59 INNOVATIVE MINING GROUP EMPHASIZES RECLAMATION

Mason, R. H., Coal Mining Process. 13 (5), 54-57 (1976). The mining and reclamation methods of Hobet Mining & Construction Co. and three affiliated companies in southern West Virginia are described. Hobet Mining developed the "haulback" method of reclamation on slopes of 65 percent and above. When the method is used there is no spoil bank on the outslope and the highwall is almost entirely eliminated. R758, Jour

### R76-60 ODOR NUISANCE IN RELATION TO SEWAGE SLUDGE DISPOSAL IN FULTON COUNTY, ILLINOIS

Masters, J. (1), Klutts, R. (1), Bergman, F. (2), and McElroy, A. D. (2) [(1) Fulton County Health Department, Canton, Illinois and (2) Midwest Research Institute], in Sludge Management Disposal and Utilization, Proceedings of the Third National Conference, Miami Beach, Florida, by ERDA, U.S. EPA, National Science Foundation, and Information Transfer, Inc., Dec. 14-16, 1976. pp 148-153. Copyright by and available from Information Transfer, Inc., 1160 Rockville Pike, Rockville, Maryland 20852 $25. Complaints of odor from the sewage disposal site on mined land used by the Metropolitan Sanitary District of Chicago have been recorded and investigated. A number of complaints were found to be valid. The methods used to evaluate and analyze the odors are described. Fulton County regulations for transport, storage, and disposal of sludge are designed to minimize the odor nuisance. CE368

### R76-61 SOIL RECONSTRUCTION: SELECTING MATERIALS FOR SURFACE PLACEMENT IN SURFACE-MINE RECLAMATION

McCormack, D. E. (U.S. Department of Agriculture), American Mining Congress Coal Show, Detroit, Michigan, May 10-13, 1976. Session Papers Set No. 4. 18 pp. The author describes the use of detailed soil profiles in determining segregation, replacement, and perhaps mixing, of horizontal sections of overburden so that reclaimed land will be as favorable as possible for vegetation. 662.6 A665

### R76-62 THE EFFECTS OF MYCORRHIZAE ON THE SURVIVAL AND GROWTH OF TREES PLANTED ON STRIPMINE SPOILS

Medve, R. J., Hoffman, F. M., and Gaither, T. W. (Slippery Rock State College), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 184-200. Growth, uptake of potassium and phosphorus, and percent mycorrhizae were found to be effected by inoculations of plantation soil, macerated roots, *Cenococcum graniforme*, and *Suillus luteus* on the roots of red pine, white pine, and black locust seedlings planted on bituminous stripmine spoil. *Cenococcum* and macerated roots had the greatest positive effects. Evidence indicates that *Pisolithus tinctorius* may be the mycorrhizal symbiont in the macerated root inoculum. More volunteer woody plants invaded the *Cenococcum* and macerated root study plots than any other area. (Authors' abstract) CE448

### R76-63 SOME EFFECTS ON SOIL MICROBIOTA OF TOPSOIL STORAGE DURING SURFACE MINING

Miller, R. M. and Cameron, R. E. (Argonne National Laboratory), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 131-139. This preliminary assessment indicates that topsoil stockpiling, under conditions present in North Dakota, leads to a disruption of soil properties as well as microbial character. Data given for both undisturbed and segregated topsoil include moisture percentage, texture, bulk density, chemical properties, organic matter content, and number of microorganisms. CE443

### R76-64 COSTS OF COAL SURFACE MINING AND RECLAMATION IN APPALACHIA

Nephew, E. A. and Spore, R. L., Oak Ridge National Laboratory, Oak Ridge, Tennessee, prepared with the assistance of Gwin, Dobson & Foreman, Inc., Mining Engineering Consultants, ORNL-NSF-EP-86 (Jan. 1976). 45 pp. Cost estimates contained in this report are based on detailed economic-engineering cost analyses of some 42 hypothetical or model mines that are typical of mining conditions in Appalachia. Nine alternative mining and reclamation methods are examined, including some recent techniques that have been developed in the attempt to alleviate the environmental impacts of coal surface mining. The results provide estimates of the cost of mining and reclamation as a function of (1) the quality of reclamation obtained, (2) the angle of natural terrain, and (3) the overburden-to-coal stripping ratio. (From authors' Introduction) R1033

### R76-65 NEW EQUIPMENT CONCEPTS ABOUND AS SURFACE-MINING TECHNOLOGY IS SPURRED BY INCREASED DEMAND FOR COAL

Coal Age *81* (10), 91-102, 107-108, 111-113 (1976). A number of different machines and methods for coal excavating and conveying and for overburden

R76-65 (continued)

handling and replacement are described. Jour

R76-66 GEOHYDROLOGY IN RECLAMATION AND MINE DESIGN

Noble, E. A. and Groenwold, G. H. (North Dakota Geological Survey), AIME Annual Meeting, Las Vegas, Nevada, February 22-26, 1976. 13 pp. Preprint No. 76-F-87. The authors discuss both the effects of mining on aquifers which are water supplies for farms and ranches in western mining areas and the adverse effects which these groundwater supplies can have on mining operations. AIME

R76-67 BIG CONSTRUCTION SIGNIFIES GROWTH AT P & M'S NEW MEXICO MINE

Nolden, C., Coal Mining Process. 13 (6), 50-55 (1976). The article describes the progress of the McKinley Mine in the San Juan coal basin. Reclamation has included soil manipulation and planting techniques to counter wind erosion and enhance vegetation. Jour

R76-68 A MODEL TO ANALYZE THE COSTS OF STRIP MINING AND RECLAMATION

Otte, J. A. and Boehlje, M., Iowa State University, Energy and Mineral Resources Research Institute, IS-ICP-3 (1976). 19 pp. The purpose of this paper is to describe a user oriented computer program for calculating the cost of mining and reclamation with various materials handling techniques and procedures in different pit configurations. Section II provides a basic overview of the strip mining process and problems encountered. Section III describes the mining cost program with emphasis on input data and procedures, the computation algorithm and the output. Section IV presents illustrative results from the analysis of the use of scrapers in various pit configurations. Finally, Section V summarizes the study and identifies other problems and policy issues that can be evaluated with the cost analysis program. (From authors' Introduction) ICP

R76-69 AN OPTIMIZING MODEL TO MATCH MINING EQUIPMENT SETS

Otte, J. A., Randolph, D., and Boehlje, M. D. (Iowa State University), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 7-18. The purpose of this paper is to illustrate the capabilities of an analytical model developed to calculate the production capacity and the costs of various combinations of coal-mining machinery. The model matches the numbers of each type of machine resulting in the least cost machine combination. First, a conceptual framework for cost calculations and machine matching is developed and illustrated. Next the costs of operating various loader-truck combinations at a given level of production are evaluated.

R76-69 (continued)

Finally, various examples are used to illustrate how the interaction of costs and production levels determine the lease cost combination of different sizes and types of machines under various job situations. (From authors' Introduction) CE 432

R76-70 THE SOIL MAP... A PREREQUISITE TO MINING AND RECLAMATION

Patterson, D. D., North Dakota Farm Research 34 (1), 12-13 (Sept.-Oct. 1976). The author discusses the use of soil maps which record the location and occurrence of various soil properties and characteristics. Knowledge of soil attributes will aid in constructing reclaimed land which is suitable for plant growth. CE499

R76-71 BETTER RECLAMATION AT REDUCED COST USING OVERBURDEN ANALYSIS

Perry, E. (West Virginia University), Green Lands 6 (4), 34-35, 37 (Winter 1976). Analysis of West Virginia overburden is based on descriptions of seven rock types generally found in the overburden in the area, on five categories of mine soils based on the prevailing rock types, and on the presence or absence of toxic materials or plant nutrients in the distinct layers of the overburden. Jour

R76-72 DIRECT SEEDING OF TREES AND SHRUBS ON SURFACE-MINED LANDS

Plass, W. T. (U.S. Forest Service, Northeastern Forest Experiment Station), Green Lands 6 (4), 24-25, 27-29, 32 (Winter 1976). In field studies on small plots, beginning in 1972 and continuing for three years, 34 species of trees and shrubs were evaluated for successful germination and growth after direct seeding. The results of these tests were used to select mixtures of species to be seeded on large acreages. Six plots were below 3,000 feet and one was above. While evaluation of these larger-scale tests would not be carried out until after the third growing season, indications after one growing season were that bicolor lespedeza, sown at the lower elevations, was suitable for direct seeding, and that, of the species used at the high elevation, Japanese larch, Norway spruce, and red spruce had germinated. There is a discussion of the way in which the characteristics of the different seeds affect the success of hydroseeding or aerial application. Germination characteristics, pretreating of seeds, and rates of application are also discussed. Jour

R76-73 USE OF SOIL MATERIALS ON SPOILS -- EFFECTS OF THICKNESS AND QUALITY

Power, J. F., Ries, R. E., and Sandoval, F. M. (Northern Great Plains Research Center, Mandan, North Dakota), North Dakota Farm Research 34 (1), 23-24 (Sept.-Oct. 1976). In experiments begun in 1970, it has been shown that even two inches of topsoil spread over impermeable, highly sodic spoils

R76-73 (continued)

greatly increased plant growth and infiltration of water. Other experiments have been carried out since 1972 at the Glenharold Mine of Consolidation Coal Company to evaluate vegetative response to various depths of topsoil on good subsoil and the mixing of subsoil and topsoil. It was found that about 30 inches of soil and subsoil cover is needed for maximum yields of spring wheat, and the maximum can be increased as better quality soil material is used. Mixed soil and subsoil gave better growth than subsoil alone but not as much yield as topsoil spread in layers over subsoil. CE502

### R76-74 RECLAMATION ENHANCES PRODUCTION FOR DLM COAL COMPANY

Green Lands 6 (2), 6-7 (Spring 1976). The company's operation in Upshur County, West Virginia, includes tree planting as part of their reclamation efforts. Jour

### R76-75 DEVELOPING A RECLAMATION PLAN FOR WESTERN SURFACE COAL MINES

Redente, E. F., Poyser, R. W., and Balzer, J. L. (Utah International, Inc.), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 39-43. The authors' proposal for developing a reclamation plan starts with a baseline environmental study which includes climatological data, inventories and classification of soils and subsoils, vegetation, and both wildlife and domestic animals. Factors in the proposed plan such as a statement of land use after mining, topsoil reuse, erosion control, grading, and the various steps in revegetation are discussed. CE435

### R76-76 REGIONAL ASPECTS AFFECT PLANNING OF SURFACE MINING OPERATIONS

Coal Age 81 (10), 119-134, 137-138, 141 (1976). The descriptions of mining methods and reclamation practices in four regions of the United States highlight some of the information in a report by Skelly and Loy to the Bureau of Mines. The report, "Economic Engineering Analysis of U.S. Surface Coal Mines and Effective Land Reclamation," was listed in BCR's first volume of reclamation abstracts as R75-22. The report can now be obtained from the National Technical Information Services as PB-245 315/7WN. Jour

### R76-77 POTENTIAL USE OF SUPPLEMENTAL IRRIGATION FOR ESTABLISHMENT OF VEGETATION ON SURFACE-MINED LANDS

Ries, R. E., Power, J. F., and Sandoval, F. M. (Northern Great Plains Research Center), North Dakota Farm Research Bulletin 34 (1), 21-22 (Sept.-Oct. 1976). The differences in using irrigation for agriculture and for establishing vegetation on reclaimed mined land are discussed. A program to use irrigation in establishing range grasses on mined land, just initiated in 1975, is described. CE426

R76-78 PERENNIAL FORAGE SPECIES RESPONSE TO SODIUM AND MAGNESIUM SULFATE

Ries, R. E., Sandoval, F. M., Power, J. F., and Willis, W. O. (Northern Great Plains Research Center), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 173-183. Magnesium and sodium sulfate are the principal salts in lignite and subbituminous coal spoils originating from the Fort Union geologic group in North Dakota, Montana, and Wyoming. Survival and growth of eight perennial forage species as affected by these salts were studied in growth chambers at three stages of plant development -- germination, emergence-establishment, and growth. Results showed that plant species responded differently to similar kinds or concentrations of salt, and that individual species responded differently to a given salt at different development stages. (From authors' abstract) CE447

R76-79 SURFACE MINED LAND RECLAMATION RESEARCH AND LEGISLATION - A PARADOX

Riley, C. V. (Kent State University), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 106-119. The development of data and knowledge concerning water management is traced and the paradox discussed is that this very significant accumulation of research data and knowledge has not been utilized in the development of mined-land-reclamation legislation. CE441

R76-80 CURRENT CRITERIA GOVERNING HEAD-OF-HOLLOW FILL MINING PRACTICES

Robins, J. D. (Skelly and Loy), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 1-6. The criteria set by West Virginia, Kentucky, and Tennessee for this overburden disposal technique are compared. The major differences in requirements of the three states are in site selection, cleaning and grubbing, internal and external drainage systems, and fill construction techniques. In discussing ways of improving head-of-the-hollow reclamation, the author identifies stability of the fill as a critical factor in the success of the method and points out that there is available information on engineering and construction experience that can be applied to mining and reclamation techniques. CE431

R76-81 PHYSICAL ENVIRONMENT OF AN ABANDONED STRIP MINE NEAR CADOMIN, ALBERTA

Root, J. D., Alberta Research Council, Bulletin 34 (1976). 33 pp. Available from Alberta Research Council, 11315 - 87 Avenue, Edmonton, Alberta, Canada, T6G 2C2. Price $5.00. An investigation of revegetation at the mine shows that soil moisture deficiency and wind are major factors inhibiting plant growth on disturbed ground in this area. High winds in fall and winter months act to reduce soil moisture, inhibit seed lodgment, remove fine particles, and abrade vegetation. Suggested remedial measures include

R76-81 (continued)

erection of snow fences, compaction of spoil piles, mixing of organic matter with spoil, and roughening of spoil surfaces after compaction. Shelter belts should be left standing during the mining phase. Geological observations at the minesite included weathering rates and groundwater analysis. Spoil weathers rapidly by physical processes; chemical weathering in the 20 years that have elapsed since abandonment is not significant. On spoil pile slopes, fine materials move downward rapidly and continuously, while the piles themselves are stable. Infiltration is high, runoff low. Groundwater quality is high and apparently little affected by passage through spoil. (From author's abstract) CE216

## R76-82 FEASIBILITY OF USING LARGE TRACTOR DOZERS IN THE SURFACE MINING OF COAL AND THE RECLAMATION OF MINED AREAS

Rush, E. S. and Willoughby, W. E., U.S. Army Engineer Waterways Experiment Station, Mobility and Environmental Systems Laboratory, Vicksburg, Mississippi, Final Report to U.S. Bureau of Mines, Miscellaneous Paper M-76-4 (March 1976). (269 pp.) NTIS, AD/A-022 852. The procedures used in this study on the costs and performances of large earth-moving equipment are similar to engineering models developed for evaluation of military ground vehicles in cross-country operations. Among the conclusions of the report are that for equal operating conditions larger machinery will greatly increase rates of earth moving and decrease costs; large tracked dozers would have an advantage over equally large wheeled dozers operating on soft ground; and that the size and requirements of the job must be carefully evaluated for a cost-effective operation. CE231

## R76-83 ECONOMIC IMPACTS OF SURFACE MINE RECLAMATION

Schlottmann, A. (1) and Spore, R. L. (2) [(1) University of Tennessee, Department of Economics and (2) Oak Ridge National Laboratory], Land Economics 52 (3), 265-277 (Aug. 1976). The authors analyze the regional economic impact of requiring back-to-contour reclamation of surface mines and the effects of surface mining regulations on strengthening the competitive economic position of underground mining. The authors conclude that "the incremental production costs from reclamation are not severe --" but warn that if a purpose of regulating strip mining is to increase use of underground mines, then a comprehensive study should be made of environmental impacts of underground mining. CE407

## R76-84 LABORATORY EVALUATION OF WAX AND SILICONE FOR WATER HARVESTING ON COAL MINE SPOIL

Scholl, D. G., U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station, Forest Service Research Note RM-321 (Aug. 1976). 4 pp. New Mexico coal mine spoil treated with either silicone or wax developed water-repellent crusts; the wax crust withstood disturbance better

R76-84 (continued)

and retained more repellency. Increasing the application rate generally improved performance of both crusts. Both treatments appear suitable for harvesting water to aid plant establishment on coal mine spoil. (Author's abstract) CE259

R76-85 CHEMICAL AND PHYSICAL CHARACTERIZATION OF COAL OVERBURDEN

Schroer, F. W., North Dakota Farm Research Bulletin 34 (1), 5-11 (Sept.-Oct. 1976). The project summarized in this article was carried out in three phases. Analyses were made of soils in potential coal-producing areas, of samples of overburden taken at five-foot increments over coal seams in mining areas or in areas to be mined, and of samples of reshaped materials taken at one-foot increments to five-foot depth. The complete description of Chama silt loam is given as an example of the type of information collected in the study. Both soils and chemical and physical properties of overburden were found to vary greatly from place to place, indicating that reclamation needs will be very site specific. "Reshaped" mine spoils have characteristics similar to those of overburden, but with less variation because of the mixing process of replacing the spoil. CE489

R76-86 A DIGEST OF ENVIRONMENTAL REGULATIONS PERTINENT TO OPEN PIT MINING IN CANADA (CURRENT AT APRIL 1975)

Shillabeer, J. H., Martin, P. S., and Whitby-Costescu, L. M., Dames and Moore, Toronto, Report to Mining Research Laboratories, Ottawa, as part of the Pit Slope Project, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, CANMET Report 76-16 (June 1976). 54 pp. Available from Printing and Publishing Supply and Services Canada, Ottawa, Canada K1A 0S9 as Catalogue No. M38-13/76-16. Price in Canada, $1.75, outside Canada, $2.10. This digest summarizes federal and provincial acts and regulations governing the environmental impact of open pit mining and lists the important agencies involved. Municipal regulations are not considered. The digest includes tables, abstracted from legislation, of objectives for quality of mine emittants. (From authors' abstract) CE175

R76-87 OVERBURDEN PROPERTIES THAT INFLUENCE MINESOILS

Sobek, A. A., Smith, R. M., Schuller, W. A., and Freeman, J. R. (West Virginia University), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 153-159. A concise description of the chemical and physical properties of coal overburden that are useful to determine prior to mining is provided. The primary property is the acid-base account which includes pH, total or pyritic sulfur, and neutralization potential. Other properties are rock type, color, nutrient status, and stability of the overburden material when exposed to the atmosphere. CE445

R76-88 SURFACE MINE HAULAGE ROAD DESIGN STUDY

Stauffer, B. E. and McClain, P. M., Skelly and Loy, Engineers - Consultants, Final Report to U.S. Bureau of Mines, Eastern Administrative Office, Pittsburgh, Pennsylvania, Open File Report 114-76 (June 1976). (258 pp.) NTIS, PB-259 634. The report recommends criteria for the design of safe surface mine haulage roads. Information relevant to road design at surface mine sites delineates vertical and horizontal alignment; subbase and surface materials; drainage; cross-slope, superelevation; runaway vehicle protection; and road and vehicle maintenance criteria. An appendix is included which details the study methods used in compiling the final report information. A bibliography following the main text lists literature referenced for the report data and which is available as a valuable tool for use by individuals involved in haul road design. (Authors' abstract) CE265

R76-89 ENGINEERING AND GEOLOGICAL AND GEOTECHNICAL ASPECTS OF SURFACE COAL MINING

Stimpson, B. (1) and West, L. J. (2) [(1) Univ. Alberta and (2) Dames & Moore], AIME Ann. Meet., Las Vegas, Nev., Feb. 22-26, 1976. 16 pp. Preprint No. 76-F-58. Factors determining slope stability of high walls, of stored piles of overburden and coal refuse, and of faces carrying haul roads include both geological and hydrological characteristics of the area. A two-step approach is recommended to obtain this type of information for planning and developing surface-mined areas. AIME

R76-90 STUDY MEASURES SURFACE MINING'S IMPACT ON WILDLIFE

Green Lands 6 (2), 46-48 (Spring 1976). Wildlife studies at West Virginia University have shown how highwalls affect deer's use of mined land, the advantages and disadvantages of planting Autumn Olive, and reclamation methods that will aid in establishing foxes and ruffed grouse on surface-mined land. Jour

R76-91 SURFACE COAL MINING IN THE NORTHERN GREAT PLAINS OF THE WESTERN UNITED STATES: AN INTRODUCTION AND INVENTORY UTILIZING AERIAL PHOTOGRAPHY COLLECTED IN 1974-75

U.S. Environmental Protection Agency, Office of Energy Activities, Region VIII, Denver, Colorado, Office of Energy, Minerals, and Industry, and Office of Research and Development, Washington, D.C., OEA 76-1 (June 1976). 146 pp. Color aerial photography is presented to portray 21 surface coal mines and one surface uranium mine located in the Northern Great Plains Coal Province of Montana, North Dakota, and Wyoming. Geologic, hydrologic, engineering, operational, and other data are also presented. Through a brief description of surface coal mining operations, the uses of aerial photography, both color and color infrared, are introduced as tools for planning and regulating surface coal mining and secondary impacts thereof. A brief synopsis and example

R76-91 (continued)

of a related effort involving satellite imagery is provided. (From abstract of the report) CE169

## R76-92 SURFACE MINING CREATES LAND FOR McDOWELL SCHOOL

Green Lands 6 (4), 10-12 (Winter 1976). The mountaintop removal method of surface mining at Tom's Mountain near Welch, West Virginia, has made 53 acres of land available for a new high school for about 1,000 students. Another high school, newly opened in Raleigh County on reclaimed surface-mined land, is also noted. Jour

## R76-93 MANAGEMENT CONSIDERATIONS IN THE PREPARATION OF ENVIRONMENTAL ASSESSMENTS FOR THE MINING OF WESTERN COAL

Syvertsen, E. M. (CH2M Hill, Inc.), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 64-75. This paper describes the differences between the regional impact statements that are being prepared for the eight western regional study areas and the site specific environmental assessments that may need to be prepared for each mine. Notes on the preparation and content of the environmental assessment are general and are presented from the management viewpoint. CE438

## R76-94 HYDROLOGIC ASPECTS OF STRIP MINING IN THE SUBBITUMINOUS COAL FIELDS OF MONTANA

Van Voast, W. A., Hedges, R. B., and McDermott, J. J. (Montana Bureau of Mines and Geology), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 160-172. Hydrologic research being conducted at several sites in southeastern Montana where pre-mining, mining, and post-mining hydrologic data can be compared is summarized. Mine cuts along aquifier outcrops created almost imperceptible piezometric changes while mine cuts between outcrops were found to induce rapid storage depletion and associated piezometric depressions. The quality of the effluents from active mines was chemically similar to other area waters. It was concluded that hydrologic effects of mining will not be catastrophic or widespread, but may have local significance. CE446

## R76-95 MULTIPLE USES OF SURFACE MINED LAND IN THE SOUTHWEST

Verma, T. R. and Thames, J. L. (University of Arizona), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 228-235. Water and land resources of the strip mined land are analyzed and evaluated for different land uses on the Black Mesa of Arizona. Runoff harvesting for agrosystems, grazing and livestock production and recreational uses of mined land has been evaluated. Soil erosion and sediment control is achieved by

R76-95 (continued)

cultural and vegetative treatments. Results should be applicable in further multiple land use planning of disturbed lands on the Black Mesa of Arizona and in other coal mining areas of the Southwest. (Authors' abstract modified)
CE452

R76-96 RECLAMATION OF WESTERN SURFACE MINED LANDS

Vories, K. C., Ed., Workshop Proceedings, Colorado State University, by ERT Energy Consultants, Inc., Fort Collins, Colorado, March 1-3, 1976. 152 pp. The Proceedings include the individual presentations and the discussions of the six sessions. Session 1. Legal and Regulatory Aspects of Land Reclamation: Hansen, R. P., "Statutory and regulatory aspects of mined land reclamation," pp 1-7; Fletcher, K., "Legal and regulatory aspects of land regulations and federal strip mine legislation," pp 8-10; McBroom, H. R., "Legal and regulatory aspects of land reclamation, the U.S. Department of Interior and Bureau of Land Management," pp 11-15. Session 2. Reclamation Planning and Economics: Cook, C. W., "Reclamation planning," pp 23-24; Howland, J. W., "Economics of leveling and contouring mine spoils," p 25; Leathers, K. L., "Reclamation as a problem in the economist's view," pp 26-28; Tuma, G., "Reclamation planning," pp 29-30. Session 3. Mining Methodology and Reclamation Planning: Ellison, R. D., "Effects of mining methodology on reclamation planning," pp 38-52; Tuma, G., "Mining methodology and reclamation planning at the Big Sky Mine, Montana," pp 53-57; Howland, J. W., "Effect of mining methodology on mine spoil reclamation costs," pp 58-62. Session 4. Planting Methods and Equipment Development: Cook, C. W., "Planting methods for reclamation of mine spoils," pp 67-68; Hodder, R. L., "Planting methods and equipment development," pp 69-82; Calhoun, D., "The vegetative rehabilitation and equipment workshop," pp 83-87; Moehller, J., "The Arch Mineral mining operation," p 88. Session 5. Seed Sources, Species Selection, and Current Research: Aldon, E. F., "Seed sources, species selection and current research on species adaptation for mine spoil reclamation," pp 99-101; Berg, W. A., "Species selection and plant soils relationships," pp 102-103; Hodder, R. L., "Seed sources, species selection and current research on species adaptation," pp 104-108; Lang, R., "Seed sources, species selection and current research on species adaptation," pp 109-111; Hassell, W., "The soil conservation service plant materials centers," pp 112-114. Session 6. Management of Reclaimed Areas: Berg, W. A., "Management of rehabilitated mined lands," pp 123-124; Moehller, J., "Management of Arch Mineral lands in Wyoming," p 125; Aldon, E. F., "Management of reclaimed areas in the Southwest," pp 126-127; Lang, R., "Management of reclaimed areas in Wyoming," pp 128-129.
631 V95

R76-97 DEVELOPING SURFACE MINE RECLAMATION PLANS

Wahlquist, B. T. (Westinghouse Electric Corp.), Mining Congr. J. 62 (1), 35-38 (1976). A good soil map, overburden analyses and segregation of toxic layers, and control of contour and slope are identified as necessary for satisfactory and economical reclamation. Jour

### R76-98 PLANTING COMBINATIONS OF TREES AND GRASSES ON AREAS AFFECTED BY SURFACE MINING IN CENTRAL PENNSYLVANIA

Wheeler, W. H. (Department of Environmental Resources), in Surface Mining and Reclamation, Fourth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 19-20, 1976. pp 215-222. As a result of segregating and replacing topsoil and subsoil in many areas, severe erosion problems have been caused. To alleviate the erosion problem it has become necessary to seed most mined lands in grass as soon as topsoil and subsoil have been applied rather than in trees. Reforestation remains the desired end land use in many areas and this paper explores some of the problems of simultaneously planting both trees and grasses. Six sites in Pennsylvania, where simultaneous planting has been tried, were investigated and the author concluded that an acceptable cover of grasses, that do not deter tree growth, can be obtained by planting approximately 15 lb of Kentucky 31 fescue and 2 lb of weeping lovegrass per acre of newly backfilled spoil where topsoil and subsoil have been replaced, and where the pH is above 5.0. It is also noted that legumes may prevent survival of most tree species and have questionable value in immediate erosion control. CE450

## 1977

### R77-1 RECLAIMING COAL MINE SPOILS IN THE FOUR CORNERS

Aldon, E. F. and Springfield, H. W., in Reclamation and Use of Disturbed Land in the Southwest, J. L. Thames, Ed., Tucson: University of Arizona Press, 1977. pp 229-237. Based on the Symposium on Disturbed Land Use and Reclamation in the Southwest, University of Arizona, Jan. 1975. The Rocky Mountain Forest and Range Experiment Station carried out cooperative studies in New Mexico with Utah International at their Navajo Mine and with Pittsburg & Midway Coal Co. at their McKinley Mine. Studies of establishment of vegetation on the nearly neutral spoils showed that fertilizer increased growth and yield of plants used in the study but did not affect seedling emergence. Plant growth was no better on topsoils of the area than on spoils. With the normal low annual precipitation in the study area, addition of water to the vegetation by irrigation and by several methods of water harvesting also increased plant growth. Direct seeding when residual soil moisture was high showed promise in establishing fourwing saltbush. Other studies indicated that addition of mycorrhizae did improve the growth of fourwing saltbush both in greenhouse and in field trials. 631 T3

### R77-2 RECLAMATION COSTS AT THE IOWA COAL PROJECT DEMONSTRATION COAL SURFACE MINE

Anderson, C. E., Colvin, T. S., and Briggs, J. M. (Iowa State University, Department of Agricultural Engineering), Annual Meeting, American Society of Agricultural Engineers, Mid-Central Region, St. Joseph, Missouri, March 25-26, 1977. Paper No. MC-77-805. 14 pp. Coal surface mining and land reclamation were planned and carried out to reclaim a gullied hillside to bench terraces suitable for row-crop farming with a minimum of added cost to mining. Environmental control and site reclamation accounted for 14 percent of total

R77-2 (continued)

mining costs. Detailed cost data are presented and discussed. (Adapted from authors' Summary) ICP

R77-3 RECLAMATION OF SURFACE MINED COAL SPOILS

Barnhisel, R. I., Kentucky Agricultural Experiment Station, University of Kentucky, Department of Agronomy, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, in cooperation with U.S. Department of Agriculture Cooperative States Research Service, Interagency Energy-Environment Research and Development Program Report, EPA-600/7-77-093 (Aug. 1977). 67 pp. Field experiments were established in western Kentucky on four types of surface-mined coal spoils. These areas were selected to represent the extremes in spoil materials commonly encountered in reclamation. This report presents evidence that mine spoils may be successfully reclaimed when proper levels of fertility have been restored. With the provision for retaining rainfall on the spoils, yields of mixed legume-fescue forage exceed 4 metric tons per hectare (2 T/acre). These yields are equal to or greater than those of adjacent non-mined land. The advantage of a rough surface created by ripping or subsoiling was obtained at all levels of applied phosphorus. The use of a chisel plow or heavy-duty disk produced a rough micro-relief that also produced significantly greater forage yields than obtained from smooth graded plots. It was found that phosphorus and water are more commonly the limiting factors in obtaining an adequate degree of vegetative cover and associated forage yield than the acidic nature of spoils. However, in acidic spoils, lime must be incorporated in order to effectively improve the growing conditions. Downward movement of lime should not be expected to occur at a rate sufficiently high to improve the growing conditions of spoils for plants. Acidic spoils also tend to be much more droughty than adjacent non-acid spoils as the result of a restricted rooting depth. (Author's abstract) EPA

R77-4 RECLAMATION PRACTICES IN THE NORTHERN GREAT PLAINS COAL PROVINCE

Barth, R. C. (Colorado School of Mines Research Institute), Mining Congr. J. 63 (5), 60-64 (1977). Spoil and topsoil handling and revegetation practices in the region are generally discussed. Both native and introduced species have been used in the area, with somewhat more success with introduced species. Spoils and topsoils of reclaimed areas are often found to be more saline than undisturbed areas. Although reclaimed areas had more bare surface than undisturbed land, the reclaimed land was more productive in terms of weight of vegetation per acre. Jour

R77-5 RECLAMATION OF TOXIC SPOIL DISPOSAL WITH POLISH SURFACE COAL MINES AS AN EXAMPLE

Bauman, K. (Central Research and Design Institute for Opencast Mining), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky.,

R77-5 (continued)

by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 225-234. NTIS, CONF-7710109. These investigations, which were sponsored by the U.S. EPA, were conducted at two mining sites in Poland. Spoil materials consisted of fine grained sands at the Przyjazn Narodow mine and heavy clayey soils at the Turow mine. Data are given concerning the neutralization procedures, fertilizing procedures, seeding mixtures, and the quantity and composition of the resultant crops with respect to type of neutralization and fertilization. Results of the investigations indicate a good grass cover can be established on heavy clayey and acid soils by the selection of proper neutralizers and fertilizers. Similar results are possible on sandy soils, however rainfall becomes of increasing importance. CE473

### R77-6 RECLAMATION PLANNING AT THE IOWA COAL PROJECT DEMONSTRATION MINE

Briggs, J. M., Anderson, C. E., and Colvin, T. S. (Iowa State University), Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, Dec. 13-16, 1977. Paper No. 77-2517. 18 pp. The development of a plan to mine a site and restore it to row-crop production involved considering mining economy, farmability, drainage, erosion control, slope stability, long term success, public safety and acceptance. The implementation of building the terraced final topography and its economic impact on the mining cost is discussed. (From authors' Summary) CE377

### R77-7 SURFACE MINE REVEGETATION: AREA METERING OF GROUND COVER

Carrel, J. E., DeMott, J. E., and Zwight, D. M. (University of Missouri), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 8-11. NTIS, CONF-7710109. A simple, two-step technique is described for remotely determining vegetative ground cover, an important indicator of surface mine reclamation. First, a transfer of plant cover visible in a large scale (1:2,500), vertical aerial photograph of the mineland is prepared by inking a clear plastic sheet. Secondly, the area occupied by vegetation is measured by passing the transfer through a leaf area meter. The method is rapid, accurate over the entire range of cover values, and inexpensive. (Authors' abstract) CE458

### R77-8 BRYOPHYTES AND REVEGETATION OF COAL SPOILS IN SOUTHERN IOWA

Carvey, K., Farrar, D. R., and Glenn-Lewin, D. C., Iowa State University, Energy and Mineral Resources Research Institute, IS-ICP-41 (undated). 14 pp.+ Also in The Bryologist 80 (4), 630-637 (Winter 1977). The occurrence and distribution of 29 mosses and 2 liverworts on these spoils was determined and related to the general process of spoil revegetation. The spoil bryophyte flora was compared with Conard's (1956) list of bryophytes for the region. An increase in percent cover and in species diversity of bryophytes was observed with increasing age of spoils, and was correlated with increased

R77-8 (continued)

vascular plant cover. Dicranella heteromalla and Ceratodon purpureus were found to be common throughout the spoils, whereas all other species were limited to more protected sites, especially on north-facing slopes. Mosses did not appear to colonize very exposed areas on the spoils, but were limited to areas with some protection provided, especially by vascular plants. Several disjunct or highly localized moss populations were found, including one new state record and thirteen new county records. (From authors' abstract) ICP, CE242

## R77-9 A STOCK ANSWER TO RECLAMATION OF SURFACE-MINED LANDS

Charton, P. (1) and Carr, E. A., Jr. (2) [(1) Roane State Community College, Harriman, Tennessee and (2) Tennessee Department of Conservation], Appalachia 10 (4), 10-13 (Feb.-March 1977). A tract of surface-mined land in the Cumberland Mountains near Jellico, Tennessee, has been reclaimed to pasture land for beef cattle. Revegetation methods and costs are described. CE232

## R77-10 BETTER WAYS TO BUILD HOLLOW FILLS

Chironis, N. P., Coal Age 82 (11), 104-110 (1977). Methods of building head-of-the-hollow fills for storage of overburden from contour or mountaintop removal mining are discussed. Recommendations, based on a previous study by Skelly and Loy, Consultants, of hollow fills in Kentucky and West Virginia, are made for improvement in drainage and to insure slope stability. Current use of the method by Kentucky and West Virginia is compared. Jour

## R77-11 PITTSTON SETS UP LARGE VALLEY FILL

Chironis, N. P., Coal Age 82 (12), 116-118 (1977). At Buffalo Mining Company's Gopher Mine in Logan County, West Virginia, a certain portion of the overburden is used to backfill the pit as the mining advances. Valley fill is also used for disposal of overburden. One valley fill has been completed and has been graded and seeded, and a second is now in use. In addition to the valley fills being designed to control drainage, there is also a pond further down the hollow to trap any sediment in storm runoff. Some of the mined site has been planted with apple trees, and slopes of the fill have been seeded with a legume, lespedeza, and a mixture of grasses. One layer of overburden, found 12 feet below the surface, has a pH of 6.5 to 7.2 and should support vegetation. Jour

## R77-12 RECLAMATION GUIDEBOOK: GUIDE TO PLANTS FOR MINE SPOILS

Chironis, N. P., Coal Age 82 (7), 122-130 (July 1977). The article describes two groups of plant materials which have been selected and evaluated by the Soil Conservation Service of the Department of Agriculture for use on mine spoils. One group has been selected mainly for use in the eastern states and

R77-12 (continued)

the other for use in the midwestern and western states. However, species from both groups have been or may be used successfully in areas other than where they were tested. Sixteen grasses, trees, legumes, shrubs, and forbs for use in the East and four grasses and one shrub for use in the West are described in detail. Jour

### R77-13 RECLAMATION GUIDEBOOK: IMAGINATIVE PLANS MAKE MINING BETTER THAN EVER

Chironis, N. P., Coal Age 82 (7), 48-51 (July 1977). The author describes the approach to reclamation of specialists in landscape design from the University of Massachusetts working with engineers from Skelly and Loy, Consultants. Aesthetics of the configuration of reclaimed land is considered in relation to the entire area and not just to a particular mined site. An example is to plan a number of mountaintop removal sites in relation to one another to avoid the monotony of many leveled peaks and retain the pleasing diversity of mountains while developing the needed flat land in hilly areas. Jour

### R77-14 A COMPUTER AIDED MINE PLANNING MODEL

Colvin, T. S., Marley, S. J., and Anderson, C. E. (Iowa State University), Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, Dec. 13-16, 1977. Paper No. 77-2518. 19 pp. A computer aided mine planning model (CAMP) has the capability of assisting in economically designing plans for small mines. CAMP can help to estimate overburden volumes and coal amounts for the total area and for individual pits. The model also has provisions for calculating strip ratios, cash flows, and rehandle percentages for various pit configurations. Secondary subroutines were developed to compute storage area volumes and mobile equipment route information. Iowa Coal Project Demonstration Mine #1 topographic information was used for verification runs of CAMP. Using the same data base, CAMP and an average end area volume calculation computer program estimated the total site volume with a difference of less than one percent. (Adapted from authors' Summary and Conclusions) CE375

### R77-15 CRAWLER TRACTORS STRIP TO 150 FT IN BLOCK-CUT OPERATION

Coal Mining Process. 14 (9), 110-111, 122, 126 (1977). With the block-cut method of surface mining used by the H & G Coal Company of Pennsylvania, overburden is moved into the previous cut to make reclaiming the land an ongoing part of the mining process. The tractors and loaders used in mining and moving the overburden are described. One area that had been mined and seeded had been a car junkyard. Jour

R77-16 A SIMULATION MODEL OF SPOIL BANK HYDROLOGY

Crosby, E. C., Overton, D. E., and Minear, R. A. (University of Tennessee), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 28-31. NTIS, CONF-7710109. The development of a mathematical model to simulate the hydrology of a contour strip mine spoil bank in the Tennessee New River Basin is detailed. Simulations of ground water flow through the ponded spoil bank studied are provided. CE463

R77-17 THE ROLE OF MICROORGANISMS IN THE REVEGETATION OF STRIP-MINED LAND IN THE WESTERN UNITED STATES

Cundell, A. M., J. Range Management 30 (4), 299-305 (July 1977). The microbial processes in soil are reviewed and are related to the characteristics of spent shale-oil waste in western Colorado and of overburden from lignite mining in North Dakota, and to the problems of revegetating these waste materials. The functions of soil organisms which the author emphasizes are accumulation of organic matter, operation of the nitrogen cycle, and pH adjustment by the action of the sulfur-oxidizing bacteria within the spoil. CE497

R77-18 SURFACE MINING COAL ON STEEP SLOPES: BACK-TO-CONTOUR DEMONSTRATION

Curry, J. A. (Tennessee Valley Authority), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 176-183. NTIS, CONF-7710109. A brief description of the Massengale Mountain, Tennessee, project, where the truck haulback mining method was used, is presented. Findings of this study show an incremental production cost of back-to-contour mining over conventional mining of approximately $2.67/ton in 1973 dollars, output per man day fell from 25.4 tons with conventional systems to 21.6 tons on the demonstration site, coal recovery per unit outcrop was almost doubled compared with that of conventional mining, and, despite having mined on slopes varying from 21 to 38 degrees, no slides have occurred where fill was placed on solid cut sections of the mountain. CE470

R77-19 SURFACE MINING AND THE FLOOD OF APRIL 1977

Curtis, W. R., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Berea, Kentucky, Forest Service Research Note NE-248 (1977). 4 pp. Data from experimental sites in Breathitt County, Kentucky, and Raleigh County, West Virginia, showed that during a major rainstorm on 4 April 1977, streamflow from surface-mined watersheds peaked lower than that from adjacent or nearby unmined watersheds. (Author's abstract). CE427

### R77-20 PERFORMANCE OF PONDEROSA PINE ON BITUMINOUS MINE SPOILS IN PENNSYLVANIA

Davidson, W. H., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service Research Paper NE-358 (1977). 6 pp. Seedlings from 40 seed sources of ponderosa pine (*Pinus ponderosa* Laws.) were planted on a strip-mine spoil in central Pennsylvania in 1969. Survival of seedlings from different sources ranged from 23 to 90 percent after six growing seasons. The average height of the seedlings ranged from 67 to 140 cm for the same period. Eight sources produced seedlings that were average or above in both height growth and survival. (Author's abstract) CE219

### R77-21 MULTI-SEAM MINING BY HAULBACK

Davis, H., Coal Age 82 (11), 134-137 (1977). Topsoil is handled by scrapers, while the rest of the coal mining and overburden handling at the operations of Johnson & Morgan Company at Snow Shoe, Pennsylvania, is carried out by loaders and trucks. Jour

### R77-22 RECLAMATION GUIDEBOOK: SPECIALIZED TOOLS FOR FINAL TOUCHES

Davis, H., Coal Age 82 (7), 112-118 (July 1977). Machinery for seeding, mulching, overburden handling, and grading is described. Jour

### R77-23 ADVANTAGES OF NATURAL SUCCESSIONAL PROCESSES ON WESTERN RECLAIMED LANDS

Ellis, S. L., Moore, R. T., and Duba, D. R. (Ecology Consultants, Inc.), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 274-282. NTIS, CONF-7710109. This paper does not report on original research but presents an overview of work conducted by others to support the authors' contention that instead of attempting to immediately restore a near climax plant community on mined land in a single step, it seems preferable to plan the revegetation and reclamation program around the ecological processes occurring on the site. Discussed are the pertinent reclamation regulations existing in Montana, Wyoming and Colorado, plant successional processes and reclamation, management strategies for influencing succession, and diversity and stability of plant communities. CE477

### R77-24 ESTABLISHMENT OF SOME FORAGE SPECIES ON MINE SPOIL IN KENTUCKY

Everett, H. W., Henry, D. S., and Sanders, S. A. (U.S. Department of Agriculture), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 12-15. NTIS, CONF-7710109. Eight different grasses and legumes were planted alone or in mixtures with five different methods of establishment. There were three replications of each method at two locations.

R77-24 (continued)

The pH was 6.0 or greater and a complete fertilizer was applied to all plots prior to seeding. Data are given for stand for 60 and 120 days after seeding and for ground cover and biomass six months after seeding. CE459

R77-25 LIMITS AND COST SENSITIVITY OF ALTERNATE PARTING HANDLING METHODS. VOLUME I

Finch, T. E., Haley, D. R., and Speake, C. J., Jr., Montana College of Mineral Science and Technology, Report to U.S. Bureau of Mines, Office of Assistant Director--Mining, Open File Report 117(1)-77 (July 22, 1977). 121 pp. NTIS, PB-270 024. The alternative methods of handling the parting (rock layers) between two coal seams in a surface mining operation consist of equipment implementation in either a stowing or haulback technique. Following a typical strip mine conformation, the parting is directly stowed or hauled back and placed in the pit bottom after second seam removal. The objectives are to produce an environmentally sound material placement technique and to increase prime stripping machine utilization. This report contains the engineering philosophy behind two computer programs created to evaluate parting handling methods over a wide range of coal and parting thickness ratios. The nature of the computer approach allows cost sensitivity analysis and quick updating of costs. The two programs are clearly presented with documentation and examples so that consumers may apply them to their own operations. (From authors' abstract) CE388

R77-26 RUNOFF AND EROSION CHARACTERISTICS OF SURFACE-MINED SITES IN WESTERN NORTH DAKOTA

Gilley, J. E., Gee, G. W., Bauer, A., Willis, W. O., Young, R. A. (Northern Great Plains Research Center, Mandan, North Dakota), Transactions of the American Society of Agricultural Engineers 20 (4), 697-700, 704 (July 1977). Measurements of runoff and erosion from simulated rainfall on rangeland, spoil, and topsoil were conducted at the Indian Head Mine of North American Coal Corporation near Zap, North Dakota. Results showed that soil loss was greatest on bare topsoil and least on noncultivated rangeland. Although a straw mulch reduced erosion from topsoil by over 90 percent, the measured erosion and runoff was still more than 50 percent higher than from rangeland. CE525

R77-27 SPECIES TRIALS ON STRIP MINE AREAS

Grandt, A. F., in Reclamation and Use of Disturbed Land in the Southwest, J. L. Thames, Ed., Tucson: University of Arizona Press, 1977. pp 347-352. Based on the Symposium on Disturbed Land Use and Reclamation in the Southwest, University of Arizona, Jan. 1975. Several species of legumes, grasses, shrubs, and trees are listed. Each is discussed considering such factors as climate and soil conditions it is best suited for; its particular purpose such as cover crop or animal feed; special needs and problems such as being

R77-27 (continued)

short lived, slow in establishing itself, or needing high nitrogen; and special advantages such as being drought resistant or acid tolerant. 631 T3

### R77-28 CLASSIFICATION OF FIVE TYPES OF STRIP MINE SPOIL AND IMPLICATIONS FOR RECLAMATION

Hall, G. F. (Ohio State University), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 1-3. NTIS, CONF-7710109. The soil series concept is proposed which will allow for the identification, classification, delineation and interpretation of distinctly different types of spoil material. Once identified and delineated as soils, information gained from reclamation research and experience can be transferred to other areas with similar soils. Based on mapping in eastern and southern Ohio, the initial five soil series being proposed are made up of strip mine spoil material with lithology ranging from limestone to "acid" sandstone and shale. CE456

### R77-29 RESEARCH ON THE HYDROLOGY AND WATER QUALITY OF WATERSHEDS SUBJECTED TO SURFACE MINING

Hamon, W. R. (1), Haghiri, F. (2), and Knochenmus D. (3) [(1) USDA North Appalachian Experimental Watershed, (2) Ohio Agricultural Research and Development Center, and (3) U.S. Geological Survey], in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 37-40. NTIS, CONF-7710109. Four small, 40 to 50 acres, watersheds, which will be at least 75% disturbed by surface mining, have been selected in southeastern Ohio to determine how surface mining impacts hydrology and water quality. The proposed instrumental design and data procurement are described in this paper. CE465

### R77-30 SUBIRRIGATED ALLUVIAL VALLEY FLOORS

Hardaway, J. R., Kimball, D. B., Lindsay, S. F., Schmidt, J., and Erickson, L. (U.S. Environmental Protection Agency, Region VIII), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 61-135. NTIS, CONF-7710109. This comprehensive paper reports efforts directed at the identification of alluvial valley floors as those areas are defined in proposed national legislation. Included are both a reconnaissance identification of subirrigated alluvial valley floors through analysis of surface features, and a preliminary analysis of hypothetical subsurface conditions that appear representative of actual conditions. An analysis of specific impacts on the hydrologic system that may result from surface methods of mining shallow coals is provided. Included in the appendicies are a list of existing and proposed western coal mine sites that include areas identified

R77-30 (continued)

as alluvial valley floors and a list of quotations from legislative proposals and Committee Conference Reports that have addressed mining in alluvial valley floors. CE468

R77-31 MANAGEMENT OF RECLAIMED SURFACE-MINED LANDS FOR ROW CROP PRODUCTION

Henning, S. J. and Colvin, T. S. (Iowa State University), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 298-305. NTIS, CONF-7710109. The pre-mining criteria used to develop a restoration plan suitable for row crop farming is given for the Iowa Coal Project Demonstration Mine described in Sendlein's paper, "Land Restoration: The Iowa Experiment," R77-78. Results are also presented for the first year studies where corn and soybeans were grown with moderate success on a restored portion of the Demonstration Mine. Data are given for original soil and for spoil characteristics, seed planters and farm tillage equipment, fertilizer requirements, and corn and soybean population densities and yield. CE479

R77-32 MICROBIAL ACTIVITY IN STRIP MINE SPOILS

Hersman, L. E., Ph.D. Thesis, Montana State University, 1977. 86 pp. Univ. Microfilms Order No. 7729304. At Colstrip, Montana, during July 1976, soil samples were collected from three native range plots and from three plots on coal strip-mined land. Measurements were made of adenosine triphosphate (ATP) concentrations, respiratory activity, phosphatase activity, pectinolyase activity, and pectinolytic plate counts. Native range soils contained higher concentrations of ATP than did the spoils and also differed from the spoils in the pattern of ATP distribution in the twelve inch soil sample column. It was concluded that respiration, phosphatase, pectinolyase, and pectinolytic plate counts measured different segments of the total soil microbial activity, since none of these correlated with one another; and that ATP measurements quantified total microbial activity because of the correlation of ATP with the total of these four parameters. (From author's abstract) Mont. St. Univ. Lib.

R77-33 PREMINING PLANNING - THE KEY TO ENVIRONMENTALLY ACCEPTABLE SURFACE MINING

Hill, R. D. (U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio), Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, Dec. 13-16, 1977. Paper No. 77-2516. 4 pp. The author discusses the specific requirements of Public Law 95-87, "Surface Mining Control and Reclamation Act of 1977" for data and information that must be collected in preparation of an application to receive a permit to surface mine. He indicates that with proper planning the operator can not only develop an environmentally acceptable surface mine, but may also be able to

R77-33 (continued)

recover part of the cost of data collection through increased efficiency in mining and reclamation. (Adapted from author's Conclusion) CE376

R77-34 RECLAMATION OF ORPHAN MINED LANDS WITH MUNICIPAL SLUDGES - CASE STUDIES

Hill, R. D. (1), Hinkle, K. R. (2), and Klingensmith, R. S. (3) [(1) U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio (2) Virginia State Water Control Board and (3) Gannett Fleming Corddry and Carpenter, Inc.], Symposium on Municipal Wastewater and Sludge Recycling on Forest Land and Disturbed Land, Philadelphia, Pennsylvania, March 23, 1977. 43 pp. The general advantages and disadvantages of sewage sludge disposal on mined land, and precautions that should be taken, are discussed. Two demonstration projects are described in detail. The Contrary Creek Project is located in Louisa County, Virginia, in an area in which there are three abandoned pyrite mines. The Tioga Demonstration Project in southeastern Tioga County, Pennsylvania, has both deep and strip mines which discharge acid drainage. Sludge analyses, seed species and application rates, and costs are given for each project. In addition, a tabulation shows acidity, sulfate, iron, copper, zinc, and manganese above and below the mine sites in Contrary Creek. CE213

R77-35 DRY LAND TECHNIQUES IN THE SEMIARID WEST

Hodder, R. L., in Reclamation and Use of Disturbed Land in the Southwest, J. L. Thames, Ed., Tucson: University of Arizona Press, 1977. pp 217-223. Based on the Symposium on Disturbed Land Use and Reclamation in the Southwest, University of Arizona, Jan. 1975. The author describes several methods of surface manipulation and planting designed to trap water. These methods will aid the establishment of vegetation for reclamation of mined land in arid regions. 631 T3

R77-36 EFFECTS OF GRAZING INTENSITY ON VEGETATION AND ANIMAL PERFORMANCE ON RECLAIMED STRIP-MINED LAND

Hofmann, L., Ries, R. E., Power, J. F., and Lorenz, R. J. (Northern Great Plains Research Center, North Central Region, USDA), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 306-310. NTIS, CONF-7710109. Duplicate sets of pastures were stocked at 0, 0.24, 0.48, and 0.72 ha/yearling steer to obtain control, and heavy, moderate, and light grazing intensities were examined on land reclaimed under the state's 1969 reclamation law near Center, North Dakota. A mixture of cool-season grasses and legumes was seeded in 1973 and not harvested before beginning the study in 1976. Steers on heavily grazed pastures produced average daily gains of 0.4 kg/head as compared with 0.9 kg/head on the moderately and lightly grazed pastures. Beef production in 1977 equalled 55, 58, and 41 kg/ha for the

R77-36 (continued)

heavy, moderate, and lightly grazed pastures, respectively. (Authors' Abstract Modified) CE480

R77-37 HOW DERELICTION IS BEING AVOIDED BUT WHO SHOULD PAY?

Mine and Quarry 6 (6), 36, 41, 44 (1977). Reclamation of lands mined for coal and for other commodities in Britain is described. Recreational areas and farming are both examples of the use of reclaimed lands. Jour

R77-38 HOW NECESSARY IS POST-EXTRACTION LAND RECLAMATION? AND HOW MUCH DOES IT COST?

Mine and Quarry 6 (2), 26, 31-32 (1977). In this report of a British conference on reclamation of mined land, the paper by E. Brent-Jones is highlighted. Information from the paper, "The agricultural restoration of opencast coal sites in Great Britain," includes planning for and costs of reclamation. Jour CE222

R77-39 GROWTH OF SELECTED PLANTS ON WYOMING SURFACE-MINED SOILS AND FLYASH

Howard, G. S. (1), Schuman, G. E. (1), and Rauzi, F. (2) [U.S. Department of Agriculture (1) High Plains Grasslands Research Station and (2) Agricultural Research Service, University of Wyoming], J. Range Management 30 (4), 306-310 (July 1977). A wheatgrass, an alfalfa, and five woody plants were grown in various ratios of topsoil and newly exposed overburdens from Wyodak Coal Mine, east of Gillette, Seminoe No. 1 Coal Mine, west of Hanna, and Utah International Uranium Mine at Shirley Basin. These greenhouse studies showed that neither the topsoil nor the overburden was detrimental to the growth of plants. Sewage sludge and manure as well as chemical fertilizers improved plant growth. Other studies showed that fly ash incorporated into spoils could support plant growth, especially with the addition of sewage sludge or manure as fertilizer. CE498

R77-40 JACOBS RANCH SELECTS OPEN-PIT MINING PLAN

Jackson, D., Coal Age 82 (11), 126-129 (1977). Reclamation at the Kerr-McGee Coal Corporation mine near Gillette, Wyoming, includes premining inventory of land use, plant cover, and soil quality variations; stockpiling of soils suitable for plant growth; and revegetation. Jour

R77-41 RECLAMATION GUIDEBOOK: WESTERN COAL IS THE BIG CHALLENGE TO RECLAMATION EXPERTS TODAY

Jackson, D., Coal Age 82 (7), 90-93, 96-97, 100, 103-108 (July 1977).

R77-41 (continued)

Climate, species used for revegetation, costs, and reclamation methods used at a number of coal companies in the Northern Great Plains, the Rocky Mountains, and the Gulf Coast region are discussed. Jour

R77-42 RESEARCH TOWARD RECLAMATION OF SURFACE-MINED LAND FOR ROW-CROP PRODUCTION

Jansen, I. J. (University of Illinois), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 25-27. NTIS, CONF-7710109. A brief description of a five year study, that has been underway less than one year, to answer questions concerning surface mining and subsequent reclamation of productive row-crop lands in Illinois is provided. CE462

R77-43 SURFACE-MINED LAND RECLAMATION METHODS

Kennedy, A. S., Zimmerman, R. E., and Carter, R., in Reclamation and Use of Disturbed Land in the Southwest, J. L. Thames, Ed., Tucson: University of Arizona Press, 1977. pp 26-40. Based on the Symposium on Disturbed Land Use and Reclamation in the Southwest, University of Arizona, Jan. 1975. Argonne National Laboratory, Environmental Systems Division, and Illinois Institute for Environmental Quality have cooperatively developed a plan for reclamation of lands surface mined in Illinois before the passage of the first state reclamation law in 1962. A computer analysis of the mined-land inventory allows calculation of reclamation costs in relation to current land use and condition and proposed end-use of reclaimed land. Some particular cost factors were tree and shrub removal, earth moving for recontouring, soil neutralization, and water treatment. 631 T3

R77-44 KNIFE RIVER KEEPS AHEAD IN RECLAMATION

Coal Mining Process. 14 (5), 84-85, 88 (1977). The reclamation program at the Beulah, North Dakota, mine of the Knife River Coal Mining Company is illustrated. Leveling of mined land and spoil piles has been carried out since 1963 with over 300 acres reclaimed to farm land. The work of the mining and earth moving equipment is also described. Jour

R77-45 UTILIZATION OF COLOR AND COLOR INFRARED AERIAL PHOTOGRAPHY IN THE SURFACE COAL MINING PROCESS

Knuth, W. M. and Fritz, E. L. (HRB-Singer, Inc.), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 4-7. NTIS, CONF-7710109. Aerial photography probably provides the only way that large

R77-45 (continued)

areas can be examined quickly and inexpensively with the amount of site specific detail normally required. Its use as a tool for collecting data on land use, vegetation, water, soils, and geology is briefly discussed. CE457

### R77-46 REVEGETATION OF STRIP-MINE SPOILS WITH CONTAINERIZED TREE SEEDLINGS

Koppe, T. F., Goodman, S. D., and Hutnik, R. J. (The Pennsylvania State Univeristy), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 16-19. NTIS, CONF-7710109. Preliminary results of a study involving various types of mined-land sites which were planted with conifer seedlings grown in various types of containers are given. Study locations included three in Pennsylvania where the soil pH was in the 3.0 to 3.3 range, two in Pennsylvania that are being reclaimed to present standards, and two each in West Virginia, Ohio, Kentucky, and Tennessee which are being reclaimed under their respective current laws. The authors concluded from the results of the first growing season that "two-year-old commercial stock planted in bare-root condition is superior to one-year-old containerized conifer seedlings on a variety of surface-mined sites." Further testing to determine whether these prelimianry results will be confirmed is recommended. CE460

### R77-47 COAL MINING AND RECLAMATION IN THE ALBERTA FOOTHILLS

Kumar, P. (1) and Sharma, K. (2) [(1) Alberta, Canada, Indian and Northern Affairs and (2) TechCan Development, Calgary], The Coal Miner 2 (2), 20-24 (June 1977). The authors describe the climate, topography and geology, soils, and vegetation of the eastern slopes area of Alberta where there are reserves of coal. They also list soil studies, methods of improving soil to enhance vegetation, and plant selection and propagation as areas where research is needed and discuss the research along these lines that has already taken place in Alberta. CE503

### R77-48 LAND USE PLANNING IN SURFACE MINE AREAS

LaFevers, J. R. (1) and Imhoff, E. A. (2) [(1) Argonne National Laboratory and (2) U.S. Geological Survey], in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 311-317. NTIS, CONF-7710109. An examination of the "Inventory of Federal Energy-Related Environmental and Safety Research" disclosed that of the 2536 programs in the Inventory only one is directed specifically at reclamation/land use planning issues. This article addresses the need for more research, the land use issues raised by 1977 Surface Mining Control and Reclamation Act, and the constraints to the attainment of land use planning goals. CE481

### R77-49 THE RELATIVE DECOMPOSITION POTENTIAL OF HABITATS VARIOUSLY AFFECTED BY SURFACE COAL MINING

Lawrey, J. D. (The Ohio State University), Canadian J. Botany 55, 1544-1552 (1977). In a 20-year-old abandoned surface coal mine area in Perry County, Ohio, fiber glass bags containing leaves from three species were set out on a non-vegetated strip-mined area, a vegetated strip-mined area, and an adjacent undisturbed area. Comparison of dry weights of leaf litter showed that during the first six months, decomposition rates differed between the bare strip-mined habitat and either of the vegetated habitats. After six months, except for *Robinia* leaves on both strip-mined habitats, decomposition rates became equalized in all habitats. Soil analyses, soil respiration data, and surveys of soil fungi show significant differences between mined and unmined areas. Leaf litter decomposition processes appear to be functionally more resistant to environmental impact than is apparent when structural diversity and complexity of soil populations are considered. (From author's abstract) CE337

### R77-50 SOIL FUNGAL POPULATIONS AND SOIL RESPIRATION IN HABITATS VARIOUSLY INFLUENCED BY COAL STRIP-MINING

Lawrey, J. D. (The Ohio State University, Department of Botany), Environmental Pollution 14 (3), 195-205 (1977). This article expands on a report, published elsewhere, of a study of mined lands in Perry County, Ohio. Conditions on three vegetated strip-mined areas, each dominated by different plant species, are compared to a bare-mined area and to an undisturbed area. Mined areas exhibited distinct differences from the unmined site. Soils in mined areas showed generally lower respiration and lower fungal diversity, with lowest diversity on the bare-mined site. CE494

### R77-51 X-RAY EMISSION MICROANALYSIS OF *CLADONIA CRISTATELLA* FROM A COAL STRIP-MINING AREA IN OHIO

Lawrey, J. D. (The Ohio State University, Department of Botany), Mycologia 69 (4), 855-860 (1977). This study was carried out to investigate how lichens accumulate heavy metals. Results indicate there is a definite localization of iron, sodium, and chlorine on the different types of cell walls, and that while iron accumulation is not by chelation with lichen acids, some property of the algal cells or cell walls makes them capable of binding iron. The samples used in this work were collected from a reclaimed mined area in Perry County, Ohio. CE545

### R77-52 COAL GOAL SAVES SOIL

Lewington, P., Agri-Book Magazine 3 (1), 150-151 (1977). The article describes the way in which the mining division of Holmes Limestone Co. in Berlin, Ohio, has stripped nearby farms for coal and restored the land to crop production. Jour

### R77-53 THE EFFECTS OF ENDOMYCORRHIZAE ON GROWTH OF RABBITBRUSH, FOURWING SALTBUSH, AND CORN IN COAL MINE SPOIL MATERIAL

Lindsey, D. L., Cress, W. A., and Aldon, E. F., U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station, Forest Service Research Note RM-343 (June 1977). 6 pp. The influence of vesicular arbuscular endomycorrhizae formed by Glomus fasciculatus on the survival and growth of rubber rabbitbrush, fourwing saltbush, and corn on coal mine spoil material was studied. G. fasciculatus endomycorrhizae increased the survival and growth of rabbitbrush but had no effect on fourwing saltbush or corn. (Authors' abstract) CE496

### R77-54 TOLERANCE OF BERMUDAGRASS SELECTIONS TO ACIDITY. I. EFFECTS OF LIME ON PLANT GROWTH AND MINE SPOIL MATERIAL

Lundberg, P. E., Bennett, O. L., and Mathias, E. L. (U.S. Department of Agriculture, Agricultural Research Service, Morgantown, W. Va.), Agronomy J. 69 (6), 913-916 (Nov.-Dec. 1977). In this study, carried out in climate-controlled chambers, three cultivars and five strains of bermudagrass were planted in low pH mine spoil and treated with six levels of lime, with addition of P, K, Ca, and Mg as determined by soil analysis. All bermudagrasses were found to tolerate acid conditions, although the various strains performed differently at different pH levels. Growth and yield were increased with increasing lime only up to about the median amount used in the study, indicating that growth is limited by toxicity of certain elements rather than by acidity. CE500

### R77-55 THE EFFECTS OF FERTILIZER AND ACID STRIP MINE SPOIL ON GERMINATION OF GRASS SEEDS

Maddox, J. B., Brown, J. E., and Bartley, G. N., Jr. (Tennessee Valley Authority), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 245-254. NTIS, CONF-7710109. When highly acid strip mine spoils are hydraulically seeded with a mixture of grasses, legumes, mulch, and fertilizer, vegetation establishment is often poor. This poor establishment may result from slurry acidity caused by fertilizer, chemistry of the spoil, or a combination of these two factors. This paper reports on a greenhouse study to determine the effects of ammonium nitrate and triple superphosphate fertilizer slurries and acid spoil on grass seed germination. Results show that caution should be taken particularly when applying these seeds in mixtures containing ammonium nitrate. CE475

### R77-56 ECOSITE: AN APPLICATION OF COMPUTER GRAPHICS TO THE DESIGN OF LANDFORMS FOR SURFACE-MINE RECLAMATION

Mallary, R. (University of Massachusetts), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 32-36.

R77-56 (continued)

NTIS, CONF-7710109. ECOSITE is described as the first comprehensive application of computer technology to the design of landforms for surface-mine reclamation and other large-scale excavation projects. This paper summarizes the essentials of ECOSITE in terms of its structure, operation, current capabilities, imminent improvements, and down-the-road performance objectives Also included are several plotter-drawn perspective views showing the quality of the graphics that can be produced even at this early stage in the evolution of computer-aided landform/landscape design. (From author's Introduction) CE464

R77-57 FALCON COAL SHINES BRIGHTLY IN EXPERIMENTAL RECLAMATION

Mason, R. H., Coal Mining Process. 14 (6), 66-70 (1977). The mining and reclamation practices at the company's operations in Breathitt County, Kentucky, are described. The reclaimed land is used for crops, grazing, growing hybrid grapes for wine making, and includes at least six ponds. Lands that have been planted with vegetation which will support wildlife are open to hunting. Jour

R77-58 SURFACE MINE HAUL ROAD DESIGN TO PROMOTE SAFE AND EFFICIENT HAULAGE

McClain, P. M. (Skelly and Loy), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 193-224. NTIS, CONF-7710109. Road design parameters which must be addressed to effect a properly constructed haulage route include a vertical and horizontal alignment, gradient, superelevation, cross slope, drainage, lane widths, and in some cases, special safety provisions. The considerations which must be given to each of these factors in initiating a safe and efficient haul road design is presented as it applies to three specific areas: alignment, cross section, and special safety provisions. Considerable data are given to aid in the design of surface mine haul roads. CE472

R77-59 WETTABILITY OF COAL-MINE SPOILS IN NORTHWESTERN NEW MEXICO

Miyamoto, S., Bristol, A., and Gould, W. L. (New Mexico State University), Soil Science 123 (4), 258-263 (1977). New Mexico Agricultural Experiment Station, Journal Paper No. 587. Laboratory tests to determine the cause of poor water infiltration of spoils of the Fruitland formation indicated that the organic matter in shiny coal is not wettable and can reduce the infiltration rate into spoils. Other causes of poor infiltration are sodic soils and fine soil texture. CE414

R77-60 SURFACE COAL MINE EVALUATION AND EQUIPMENT SELECTION

Morey, P. (1) and Draffin, C. W. (2) [(1) Fluor Utah, Inc. and (2) U.S. Department of Energy], in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 136-175. NTIS, CONF-7710109. A series of computer models that can be used in large-scale surface coal mine planning and analysis has been developed. Each major operation in the coal mining process is represented in these models so that the best methods and equipment may be selected and so that the impact of such selection will be reflected in estimates of capital investment, operating costs, and coal price. Individual models allow the user to separately analyze overburden removal, overburden drilling and blasting, coal drilling and blasting, coal loading and hauling, coal preparation and handling, land reclamation, and premining, facilities, and administrative expenses. Because it is impossible to cover all the models in this paper, only the detailed simulation models representative of area stripping with shovels-and-trucks mining techniques are described. The Powder River Basin Strippable Coal Resource Region, one of eight test cases, is used as an example to describe the models. All costs are shown in 1975 dollars with no escalation. CE469

R77-61 MOUNTAINTOPPING AN OLD STRIP MINE

Coal Age 82 (11), 60-62 (1977). High grade metallurgical coal is being mined by Vecellio & Grogan, Inc., at an old contour mine in West Virginia. In the continuous reclamation process, overburden is spread on mined areas and stockpiled topsoil is spread to a depth of two to four feet. Outslopes are graded and planted with pine trees, leveled areas are planted with grasses and legumes. Provisions are made for drainage and erosion control. Machinery used for mining and earth moving is described. Jour

R77-62 ILLINOIS' MINED LAND INVENTORIES: THEIR IMPLEMENTATION AND UTILIZATION

Nawrot, J. R. and Klimstra, W. D. (Southern Illinois University at Carbondale), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 54-60. NTIS, CONF-7710109. The Illinois Abandoned Mined Land Reclamation Act of 1975 empowered the State to acquire abandoned mined lands and restore them to productive use. Acquisition priorities were established and, to secure the necessary data concerning the abandoned sites, two surveys, for surface and for underground mines, were funded. This paper details the methodology used in conducting the inventories and speaks to their use within the State and, potentially, as part of a regional or national program. CE467

R77-63 NEW EQUIPMENT RECLAIMS SPOIL BANKS IN KANSAS

World Coal 3 (2), 25 (1977). The Pittsburg & Midway Coal Mining Co., in conjunction with the Bureau of Mines, has developed angle blades, a Vee-plow, and a grading bar for more economical overburden grading and handling in surface-mine reclamation. Jour

R77-64 OPTIMIZE YOUR SURFACE MINING & RECLAMATION OPERATIONS

Coal Mining Process. 14 (6), 71-80, 82, 116 (1977). Walking draglines, power shovels, front end loaders, hydraulic excavators, coal haulers and off-highway trucks, dozers and crawler tractors, and scrapers, as well as drilling tools and machinery, and conveyor systems are discussed in detail, with emphasis on how to use the equipment most effectively. Jour

R77-65 REESTABLISHMENT OF WOODED WATERWAYS AND ASSOCIATED UPLAND SHRUB COMMUNITIES IN SURFACE COAL MINING AREAS OF THE NORTHWESTERN GREAT PLAINS

Orr, H. K. (Rocky Mountain Forest and Range Experiment Station), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 235-244. NTIS, CONF-7710109. The studies described began in 1973 and were conducted at AMAX Coal Company Belle Ayr mine and ARCO's Black Thunder Coal lease area. Parameters studied included a variety of native upland shrubs and woody species, precipitation, bare root and container grown stock, supplemental irrigation, mulch, and fertilization. CE474

R77-66 COAL SURFACE MINING RECLAMATION COSTS IN THE WESTERN UNITED STATES

Persse, F. H., Lockard, D. W., and Lindquist, A. E., U.S. Bureau of Mines, IC 8737 (1977). 34 pp. Reclamation cost estimates for 13 surface coal mines in nine states west of the Mississippi River were made by using standard estimating procedures from data obtained from company records, interviews with industry personnel, and onsite observations. Estimated costs are presented in four categories which represent the four phases of mined-land reclamation: (1) Design, engineering, and overhead; (2) bond and permit fees; (3) backfilling and grading; and (4) revegetation. Estimated costs as of the first quarter of 1976 are expressed as averages and ranges in terms of per acre, per ton of coal produced, and per million Btu. A mine in the Northern Great Plains coal province (Region D) showed the highest per acre cost whereas mines in part of the western region of the Interior coal province (Region A) experienced the greatest per ton and per million Btu cost. The high cost of reclamation in the Western United States is reflected in the backfilling and grading category, particularly in the cost of topsoil removal and subsequent replacement as required by individual State reclamation regulations. (From authors' abstract) BurM

### R77-67 RECLAIMING SURFACE-MINED LAND IN WEST KENTUCKY

Powell, J. L. (1) and Barnhisel, R. I. (2) [(1) Peabody Coal Co. and (2) University of Kentucky], Mining Congr. J. 63 (12), 29-35 (1977). Reclamation of Kentucky spoils is discussed in relation to grading, seedbed preparation, spoil testing and fertility amendments, climate and species selection, mechanics of seeding and post-seeding management, and potential uses of reclaimed surface-mined land. Methods of grading to minimize compaction of spoils that causes runoff and erosion are described. On a Peabody Coal Company site, a comparison of methods of preparing seedbeds showed that the use of the industrial disk harrow was economical and effective for establishing vegetation. The testing for and requirements of Kentucky spoils for lime, phosphorus, potassium, and nitrogen are discussed. Effects of Kentucky climate on revegetation are noted, and a number of successfully used species are listed with their recommended planting dates and seeding rates. Mixtures of legumes and grasses commonly used in Kentucky are also listed. The authors point out that Kentucky regulations prevent reclamation of land to row-crop production and also restrict the types of wildlife habitat that can be developed on mined land. Jour

### R77-68 THE STATE OF THE ART OF RECLAIMING LAND SURFACE-MINED FOR COAL IN THE WESTERN KENTUCKY COAL FIELD

Powell, J. L. (1), Barnhisel, R. I. (2), Akin, G. W. (2), and Ebelhar, M. W. (2) [(1) Peabody Coal Company and (2) University of Kentucky], in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 255-273. NTIS, CONF-7710109. A summary of five years of research and observations by Peabody Coal Company that can be used as guidelines in planning, implementing and maintaining a sound reclamation program is presented. Described in detail are grading, spoil sampling and testing, plant species selection, adaptation characteristics of eleven species, fertilizer and lime amendments, seedbed preparation, mechanics of seeding, and potential uses of reclaimed mined land. CE476

### R77-69 A PROGRESS REPORT: RECLAIMING SURFACE MINED LAND IN SOUTHWEST VIRGINIA

Virginia Polytechnic Institute and State University in cooperation with the Tennessee Valley Authority (undated). (17 pp.) Mined-land reclamation described and illustrated includes an area used by wildlife, development of level land, fruit and vegetable garden areas, and grazing land. CE325

### R77-70 THE ECOLOGICAL EFFECTS OF COAL STRIP-MINING: A BIBLIOGRAPHY WITH ABSTRACTS

Ralston, S., Hilbert, D., Swift, D., Carlson, B., and Mengies, L., Colorado State University, Natural Resource Ecology Laboratory, Report to U.S. Fish and Wildlife Service, Western Energy and Land Use Team, as a part of U.S. EPA

R77-70 (continued)

Federal Interagency Energy/Environmental Research and Development Program, FWS/OBS-77/09 (March 1977). 416 pp. NTIS, PB-265 316. Publications listed in this bibliography are related mainly to mining and reclamation of surface-mined lands in western United States, especially the Northern Great Plains, and are arranged in the following major categories: Climate and Topography; Soils and Spoils; Aquatic Components; Plants; Animals; General Reclamation; Human Components; Techniques and Methods of Reclamation; Computer Models and Programs; Options and Alternatives to Mining Techniques; Symposia and Conferences; and Bibliographies. A number of the citations have annotations or abstracts. The Significant Word in Title index which makes up Part II is an alphabetized, permuted arrangement using only meaningful words in the titles. 631 R16

R77-71 RECLAMATION GUIDEBOOK: HACKING THROUGH THE PERMIT JUNGLE

Coal Age 82 (7), 57-65 (July 1977). A table reprinted from a Dames & Moore study summarizes the surface mine reclamation requirements in force in 27 states, in relation to such topics as bonds, overburden analysis and handling, and revegetation. Jour

R77-72 RECLAMATION GUIDEBOOK: HAULBACK RECLAIMS NATURALLY

Coal Age 82 (7), 70-72, 75-76, 79-83 (July 1977). The haulback method of handling surface-mining overburden is used widely in Kentucky, West Virginia, and Tennessee. The survey of the mining process by Mathematica, Inc., is summarized. The use of the method by the Grafton Coal Company in West Virginia, analyzed in detail by Skelly and Loy, Consultants, is reviewed. Jour

R77-73 RECLAMATION OF OPENCUT SPOIL PILES

Australian Mining 68 (7), 17-19 (1977). Utah Development Company is carrying out reclamation of spoil piles at its four surface mines in Central Queensland, Australia. Recontouring includes drainage and erosion control and preparing the surface for sowing. After four years of field studies, a mixture of Rhodes, Green Panic, and Buffel pasture grasses and Siratro, a legume, was found to give successful revegetation. CE413

R77-74 TOTAL UTILIZATION OF A LAND RESOURCE

Reiss, I. H. (Meadowlark Farms Inc.), Mining Congr. J. 63 (10), 55-59 (1977). In describing the reclamation program of Amax Coal Company which, through its subsidiary Meadowlark Farms, has reclaimed mined land to agricultural uses, the author questions the concept that land that was used for corn before mining should be returned to corn after mining. He cites the efficient transformation of the protein in alfalfa by beef cattle to a form consumable by humans as an advantageous use of reclaimed land. Jour

R77-75 RESTORATION AFTER OPENCAST MINING AND QUARRYING

Mine and Quarry 6 (4), 15-16, 19 (1977). Some of the reclamation activities of the National Coal Board, including those at sites in Derbyshire and Scotland, are reviewed. Jour

R77-76 WILDLIFE OPTION IN KENTUCKY

Rosso, W. A. (1) and Wolcott, B. H., Jr. (2) [(1) Peabody Coal Company and (2) Pittsburg and Midway Coal Mining Company], in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 20-23. NTIS, CONF-7710109. The development of the wildlife option in reclaiming spoils in Kentucky is traced. Peabody Coal Company's Ken Mine was chosen for the first wildlife option area and details are given for the development of shrub rows, annual plant plots, and fish stocking of the final pit impoundment. CE461

R77-77 SOIL GENESIS, HYDROLOGICAL PROPERTIES, AND ROOT CHARACTERISTICS OF 2 TO 53 YEAR OLD STRIPMINE SPOILS

Schafer, W. M., Nielsen, G. A., and Dollhopf, D. J., Montana State University, Agricultural Experiment Station, Research Report 108, Progress Report 1 to U.S. Department of Agriculture, Cooperative States Research Service (Report date 6/18/76, issued April 1977). 90 pp. In this study, relationships between root characteristics, soil properties, and the soil-water regime in spoils will be examined. Changes in spoils through time may affect root properties and water movement. Therefore, soil genesis on spoils ranging from 1 to 52 years in age will also be evaluated. Native range sites representing the spectrum of soils in the Colstrip area will be used as indices to which spoils will be compared. (From authors' abstract) CE490

R77-78 LAND RESTORATION: THE IOWA EXPERIMENT

Sendlein, L. V. A. (1), Anderson, C. E. (2), and Gulliford, J. B. (2) [(1) Southern Illinois University at Carbondale and (2) Iowa State University], in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 283-297. NTIS, CONF-7710109. This project is designed to investigate the restoration economics and environmental impact of strip mining in Iowa. The research mine is located on a 40-acre site, containing two coal seams with the lower seam being three feet thick and covering 20 acres and the upper seam being five feet thick and covering five acres. Mining method used is the modified haul-back system, using dozers and scrapers. Environmental studies included a pre-mining archeological traverse surface and ground water studies, pre-mining vegetation characterizations, and reclamation effectiveness. Mining and reclamation are described and costs are given for both. CE478

### R77-79 MOUNTAIN-TOP REMOVAL AS APPLIED TO MULTIPLE-SEAM MINING

Stevens, C. A. (Falcon Coal Company, Inc.), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 184-192. NTIS, CONF-7710109. Three methods of mountaintop removal are examined and discussed relative to their application advantages and disadvantages. The three methods are: the progressive method, the area method, and the cross-ridge method. Of the three, the cross-ridge plan has the most limitations. The progressive method is the most popular due to its almost unlimited flexibility. The area method offers the most promise for medium to large operations. CE471

### R77-80 SUNEDCO'S NEW CORDERO FACILITIES INTEGRATE STRIP MINING & RECLAMATION

Coal Mining Process. 14 (7), 46-47 (1977). In connection with the mining of a 58-foot thick Wyodak coal seam in the Powder River Basin of Wyoming, SUNEDCO is conducting cooperative reclamation research and reclaiming mined land to agriculture. Jour

### R77-81 RECLAMATION ON THE BLACK MESA OF ARIZONA

Thames, J. L. and Verma, T. R. (University of Arizona), Mining Congr. J. 63 (9), 42-46 (1977). The geology, hydrology, climate, vegetation, and animal life on the Mesa are described. Overgrazing is a current problem and is seen as one reason for the poor condition of unmined land. The reclamation plans of Peabody Coal Company at its Black Mesa Mines are summarized. Jour

### R77-82 IMPACT OF EARTHWORM INTRODUCTION ON LITTER BURIAL AND NUTRIENT DISTRIBUTION IN OHIO STRIP-MINE SPOIL BANKS

Vimmerstedt, J. P. and Finney, J. H. (Ohio Agricultural Research and Development Center), Soil Science Society of America Proceedings 37 (3), 388-391 (1977). Field experiments were carried out on calcereous spoils from mining Meigs Creek coal in southeast Muskingum County, Ohio, and field and greenhouse experiments were carried out on dark acid spoils from mining Lower Kittanning coal in northwest Tuscarawas County, Ohio. In both spoils, earthworms were found to survive for more than five years, and to consume significant amounts of litter. Earthworm activity did not affect the growth of seedlings of northern red oak. CE487

### R77-83 STRIP-MINING AND SMALL MAMMALS IN SOUTHERN IOWA

Voight, J. R. and Glenn-Lewin, D. C., Iowa State University, Energy and Mineral Resources Research Institute, IS-ICP-44 (April 1977). 16 pp. Small

R77-83 (continued)

mammal presence, diversity and reproduction were compared from August 1975 to June 1976 on abandoned coal strip-mine spoils and unmined land in southern Iowa. More species were snap-trapped on the unmined area, while the relative dominance of Peromyscus spp. on mined land was increased. Peromyscus population on mined land exhibited a shorter breeding season than on unmined land. Other population parameters did not show clear differences between the areas. (From authors' abstract) ICP

R77-84 METHOD AND APPARATUS FOR STRIP MINING

Watts, J. P., U.S. Pat. 4,025,119 (May 24, 1977). 8 pp. The apparatus described in this patent removes overburden and coal from a vertical shaft, places the overburden in a previously excavated shaft, and conveys the coal separately to storage. US Pat

R77-85 A SELECTIVE BIBLIOGRAPHY OF SURFACE COAL MINING AND RECLAMATION LITERATURE. VOLUME 1. EASTERN COAL PROVINCE

Weiss, N. E., Sobek, A. A., and Streib, D. L., Argonne National Laboratory, Energy and Environmental Systems Division and Environmental Impact Studies Division, Argonne Land Reclamation Program, Report to U.S. Department of Energy, ANL/LRP-1 (Nov. 1977). 158 pp. This bibliography has been compiled for use by researchers, students, and other groups who need a reference source of published literature related to surface coal mining and reclamation in the Eastern Coal Province. This bibliography contains more than 1300 references including government reports, journal articles, symposium proceedings, industrial reports, workshop proceedings, theses, and bibliographies. A simple format was used to categorize citations. (Authors' abstract) DOE

R77-86 KEEPING THINGS CLEAN WITH SOAP AND WATER

Wiram, V. P. (AMAX Coal Company), in Surface Mining and Reclamation, Fifth Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 41-53. NTIS, CONF-7710109. Outlined are the objectives and methodologies of both the SOAP (Soil Overburden Analysis Program) and Hydrology programs that have been instituted by AMAX Coal Co. to bring all surface-mine operations into total compliance with the Surface Mining Control and Reclamation Act of 1977. The basic steps followed in the SOAP program for both the soil inventory and the unconsolidated and bedrock inventory are described. The Hydrology program involves assessment of drainage basins and watersheds, surface water quality, mine water quality, ground water, and aquifer characterization, both within and adjacent to the mine properties. Also described is the AMAX Environmental Section and their function and responsibilities. CE466

## 1978

### R78-1 RECLAMATION OF COAL-MINED LAND IN THE SOUTHWEST

Aldon, E. F. (Rocky Mountain Forest and Range Experiment Station), J. Soil and Water Conservation 33 (2), 75-79 (March-April 1978). The author describes the coal fields of the region and their soils, climate and vegetation. Alkali sacaton, western wheatgrass, fourwing saltbush, and Indian ricegrass are identified as the species that are most promising for revegetation in the region. Several satisfactory methods of planting and seeding have been developed for the various species. Vegetative establishment is enhanced by spoil amendments including organics, topsoil, mulches, and fertilizers, and by additional water. CE524

### R78-2 OUR RECLAMATION FUTURE, THE MISSING BET ON TREES

Ashby, W. C., Kolar, C. Guerke, M. L., Pursell, C. F., and Ashby, J., Southern Illinois University, Department of Botany, Report to Illinois Institute for Environmental Quality, Project No. 80.057, IIEQ Document No. 78/04 (Jan. 1978). 99 pp. Also published as "Our reclamation future with trees," Southern Illinois University, Coal Extraction and Utilization Research Center, CEURC - 2, (August 1978). The authors recommend tree planting as a desirable reclamation alternative which should be given more consideration than it currently is. The recommendation is based on a survey conducted in 1976 of trees planted almost 30 years before on mined land in Illinois. In the survey, 13,236 trees on 134 plots were measured and 785 soil samples were collected. The results of the survey are discussed and form the basis for further discussions of environmental, recreational, educational, social, and economic impacts of forestation. CE517

### R78-3 OPENCAST AT MEADOWGATE

Bryson, N. and Chance, J., Mining Magazine 139 (1), 26-27, 29, 31 (July 1978). A park and lakes are being developed on an area where coal outcrops and where surface mining and some shallow underground mining had previously taken place. The plan for further mining, combined with reclamation, is described. The River Rother will be temporarily diverted and then will be returned to another permanent course as the work is completed. CE519

### R78-4 RESEARCH ON REVEGETATION OF SURFACE MINED LANDS AT COLSTRIP, MONTANA: PROGRESS REPORT, 1975-1977

DePuit, E. J., Coenenberg, J. G., and Willmuth, W. H., Montana State University, Agricultural Experiment Station, Bozeman, Montana, Research Report 127 (Aug. 1978). 165 pp. The research covered by this report, funded by Western Energy Company, includes studies on the use of Wintergraze; investigation of which of four legumes was superior in terms of productivity and longevity; reestablishment of ponderosa pine; the possibility of growing

R78-4 (continued)

cereal grains; evaluation of a number of plant species; plant community development and surface manipulation studies; the effects of slope gradient on topsoil stability and vegetation development; dryland pasture studies; and plant successional studies. The study currently in progress on native versus introduced species is reviewed. Several discontinued studies are summarized. CE537

R78-5 MINED-LAND RECLAMATION IN THE INTERIOR COAL PROVINCE

Grandt, A. F. (Peabody Coal Company), J. Soil and Water Conservation 33 (2), 62-68 (March-April 1978). The author reviews reclamation practices in the region, from the planting of the first trees in 1916, and traces the development of laws and regulations governing reclamation in the various states of the region. He also reviews the climate and the characteristics of the mined lands of the Interior Coal Province and discusses a number of plants used successfully for revegetation. Use of reclaimed land has included several kinds of farming, recreation, wildlife habitat, and housing developments. The author also discusses the costs of reclamation and points out how differing land characteristics and state requirements affected these costs before Federal Regulations required restoration to premining or better land use. CE522

R78-6 LAND RECLAMATION PROGRAM

Argonne National Laboratory, Annual Report July 1976-October 1977 to U.S. Department of Energy, ANL/LRP-2 (May 1978). 163 pp. The report includes a summary of activity at Big Horn Mine/Tongue River Project and Jim Bridger Mine Project in Wyoming; development of water harvesting techniques at Black Mesa Mine, Arizona; vegetation studies at the Navajo Mine in New Mexico; the groundwater study at Goose Lake Prairie State Park in Grundy County, Illinois; the reclamation of a mined area at the Burning Star Mine Number 3 in southern Illinois to row crops; the reclamation of coal refuse disposal sites in Macoupin County, Illinois. Laboratory studies on the recovery of soil biota after land is disturbed by surface mining are also reviewed. The development of the computerized data and information retrieval system is described. An appendix lists publications by members of the program staff. CE11

R78-7 EFFECTS OF WETTING AGENTS ON WATER INFILTRATION INTO WATER-REPELLENT COAL MINE SPOILS

Miyamoto, S. (Texas A&M University, Research Center), Soil Science 125 (3), 184-187 (1978). The greenhouse tests performed on the high coal-content mine spoils of the Fruitland formation from Utah International's Navajo Mine in New Mexico are described. The three commercially available wetting agents studied were an alkyl polyethylene glycol ether, an ethoxolated alcohol, and a linear sulfonate. The sulfonate compound performed better

R78-7 (continued)

than the other wetting agents and improved infiltration both when applied on soil and when applied in water. Its effect, when soil-applied, persisted through repeated irrigations. The tests also included the incorporation of wettable material into the water-repellent spoil. Results showed 1) that more than 10 percent of the mixture had to be wettable material for the most improvement in infiltration, and 2) that the effect of the amendment decreased after repeated irrigation. CE495

## R78-8 RECLAMATION OF COAL-MINED LAND IN APPALACHIA

Plass, W. T. (Northeastern Forest Experiment Station, Princeton, W. Va.), J. Soil and Water Conservation 33 (2), 56-61 (March-April 1978). Reclamation studies in Appalachia have included overburden placement, use of topsoil, soil amendments, selection of plant materials, site preparation, application of seeds and fertilizer, and mulches and soil stabilizers. There is an extensive list of grasses, legumes, trees, and shrubs used in revegetation of surface-mined land in Appalachia. CE521

## R78-9 RECLAMATION OF COAL-MINED LAND IN THE NORTHERN GREAT PLAINS

Power, J. F., Ries, R. E., and Sandoval, F. M. (Northern Great Plains Research Center, Mandan, North Dakota), J. Soil and Water Conservation 33 (2), 69-74 (March-April 1978). The problems of mining and reclamation in the region are discussed with emphasis on the need for water conservation and the difficulties of revegetating the sodic and plant nutrient deficient spoils. CE523

## R78-10 PLANT PERFORMANCE ON SURFACE COAL MINE SPOIL IN EASTERN UNITED STATES

Ruffner, J. D., U.S. Department of Agriculture, Soil Conservation Service, SCS-TP-155 (April 1978). 76 pp. This report summarizes the results from 1946 to 1976 of Soil Conservation Service (SCS) plant evaluations from all states in the eastern coal mining region, including data from field planting plans and annual reports of SCS plant materials centers. Species and field observations are tabulated. Species that have widespread use or are best suited to special uses are discussed as are special cultural and management practices required for a given species or site condition. (Adapted from author's Source of Data) CE535

## R78-11 LABORATORY METHODS RECOMMENDED FOR CHEMICAL ANALYSIS OF MINED-LAND SPOILS AND OVERBURDEN IN WESTERN UNITED STATES

Sandoval, F. M. and Power, J. F. (Northern Great Plains Research Center, Mandan, North Dakota), U.S. Department of Agriculture, Science and Education

R78-11 (continued)

Administration, Agriculture Handbook Number 525 (April 1978). 31 pp. For sale, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 Stock No. 001-000-03763-3 The handbook was compiled to meet a need for care in sample collection and handling and for uniform laboratory methods to evaluate plant growth capabilities and limitations associated with coal lands in western United States. Salinity associated with sodium and nutritional deficiencies commonly characterize these materials, therefore the procedures were selected accordingly. The authors drew heavily from methods recommended by the U.S. Salinity Laboratory, Riverside, Calif., and terminology common to saline-sodic soil technology was used. The procedures selected are those with which the authors have experience and which they believe are most widely accepted as reference or standard procedure for western mined lands and associated spoils. Those methods presented have been related to plant growth responses and may be used as a reference against which other methods may be compared. (Authors' abstract adapted) CE530

## R78-12 BLACK WALNUT ON KANSAS STRIP MINE SPOILS: SOME OBSERVATIONS 25 YEARS AFTER PRUNING

Shigo, A. L., Rogers, N. F., McGinnes, E. A., Jr., and Funk, D. T., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service Research Paper NE-393 (1978). 14 pp. Dissections of 14 slow-growing black walnut trees on a strip-mine site in southeastern Kansas near Pittsburg revealed that bands of discolored heartwood were associated with pruned and nonpruned branch stubs. Ring shakes were associated with a few pruned and nonpruned stubs, especially with groups of stubs at the same position on the stem. The advantage of early pruning was that even the defects that developed were compartmentalized within the small nonmerchantable central core that was the diameter of the tree at the time of pruning. (Authors' abstract adapted) CE501

## R78-13 SHEAR STRENGTH OF SURFACE-MINE SPOILS MEASURED BY TRIAXIAL AND DIRECT SHEAR METHODS

Superfesky, M. J. and Williams, G. P., Jr., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service General Technical Report NE-39 (1978). 15 pp. Results of measurements of seven surface-mine spoils by triaxial and direct shear methods indicated that the direct shear method may be used for evaluating the shear strength parameters of surface-mine spoils. The average angle of internal friction determined by direct shear testing was 38.6°; the average value for the triaxial method was 33.4°. The average value of cohesion determined by direct shear testing of dry materials was .077 bar; the average value of cohesion determined for the triaxial method was .100 bar. Soaking specimens immediately before direct shear testing reduced the average angle of internal friction by 8.2°; there was no significant change in cohesion. The methods used to sample, blend materials, and prepare specimens caused two distinct populations for

R78-13    (continued)

triaxial test results. The ratio of freshly crushed materials to weathered materials in a specimen affected triaxial results more than direct shear results. (Authors' abstract) CE520

# AUTHOR INDEX

Ackerman, W. C.
  R74-17
Adams, L. M.
  R71-27   R71-30   R71-48
  R72-1
Agnew, A. F.
  R73-1
Aharrah, E. C.
  R73-2
Ahmad, M. U.
  R71-1   R73-3   R73-170
  R74-1
Akin, G. W.
  R75-3   R77-68
Albrecht, J.
  R76-1
Aldon, E. F.
  R73-4   R73-171   R75-1
  R75-74   R75-75   R76-2
  R76-96   R77-1   R77-53
  R78-1
Alexander, S. S.
  R73-5
Allen, J. C.
  R73-13   R73-168   R73-169
Allen, N., Jr.
  R73-6   R74-2
Allen, O. R.
  R75-32
Allen, R. H., Jr.
  R75-77
Allen, S. E.
  R73-12
Amato, R. V.
  R73-161
Anderson, A. T.
  R75-78   R76-3   R76-4
Anderson, C.
  R75-121
Anderson, C. E.
  R75-87   R77-2   R77-6
  R77-14   R77-78
Anderson, J. C.
  R71-30
Anderson, J. I.
  R62-1
Anderson, R. J.
  R74-15
Andreuzzi, F. C.
  R76-5
Angel, P. N.
  R76-6
Antalovich, J. W.
  R73-3   R73-170
Arata, A. A.
  R57-1   R59-1
Arkle T., Jr.
  R74-88
Armiger, W. H.
  R72-69   R73-76   R75-30
  R76-7   R76-13
Arnold, G. E.
  R74-47
Arnott, D., Jr.
  R50-3
Ashby, J.
  R78-2
Ashby, W. C.
  R78-2
Ashton, P. M.
  R75-125
Atkinson, R.
  R73-136
Atwood, G.
  R75-79
Augustine, M. T.
  R64-1

Babcock, A.
  R72-3
Bagge, C. E.
  R73-8   R74-4
Baisden, H. L.
  R74-5
Bakeis, W.
  R69-22
Baker, C. D.
  R64-1   R76-8
Balasko, J. A.
  R71-30
Ballou, S. W.
  R75-80   R76-9
Balsinger, T. R.
  R57-2
Balzer, J. L.
  R74-6   R75-2   R76-75
Bardwell, R. O.
  R76-10

# AUTHOR INDEX

Barnhisel, R. I.
R69-1 R72-35 R75-3
R77-3 R77-67 R77-68
Barrau, E. M.
R73-15
Barth, R. C.
R77-4
Bartley, G. N., Jr.
R77-55
Bauer, A.
R77-26
Bauer, E. A.
R67-1
Bauer, H. J.
R73-9 R73-10
Bauman, K.
R74-109 R75-81 R76-11
R76-12 R77-5
Baumgardner, R. G.
R74-7
Beach, B. A.
R72-68 R73-11
Bean, S. D.
R73-132
Beattie, J. M.
R57-6
Beauchamp, H.
R75-82
Beck, R. E.
R73-172
Becker, J. L.
R74-33 R75-92
Beckner, J. L.
R74-51
Bell, R.
R56-1
Benecke, K. J.
R75-83
Bengtson, G. W.
R73-12 R73-13 R73-168
R74-59
Bennethum, G.
R74-9
Bennett, D. A.
R76-15
Bennett, O. L.
R71-30 R72-69 R75-30
R76-7 R76-13 R77-54
Berg, W. A.
R67-3 R68-15 R69-2
R69-23 R73-14 R73-15
R73-16 R73-157 R74-8
R75-84 R75-85 R76-96
Bergman, F.
R76-60
Bergoffen, G. S.
R62-2
Berklund, C.
R74-9
Berkowitz, N.
R69-3
Bernath, G. E.
R64-32
Binder, D.
R73-173
Birkenholz, D. E.
R58-4 R62-12
Bitler, J. R.
R75-5 R75-95
Blakely, J.
R73-17 R74-10 R74-11
R75-6 R75-7
Blazenko, E. J.
R76-14
Blizzard, S. H.
R74-12
Boccardy, J. A.
R68-1
Bodner, R. M.
R72-4
Boehlje, M.
R75-45 R76-68 R76-69
Bohm, R. A.
R74-13
Bond, J. J.
R73-129 R73-185
Bond, R. L.
R73-90
Borden, F. Y.
R73-50 R73-86
Bowden, K. L.
R61-1
Bowersmith, J. A.
R76-15
Box, T. W.
R74-14
Boyce, L.
R72-43

## AUTHOR INDEX

Boyce, S. G.
R59-2 R59-3
Boyce, T. A.
R75-8
Bradshaw, A. D.
R74-115
Bramble, W. C.
R48-1 R49-6 R52-1
R73-96
Branson, B. A.
R71-2
Brant, R. A.
R64-2
Brawner, C. O.
R75-9
Breeding, C. H. J.
R61-2
Brenner, F. J.
R72-5 R75-10
Brent-Jones, E.
R77-38
Breslin, J. J.
R74-15
Brewer, R.
R56-6 R58-1
Briggs J. M.
R77-2 R77-6
Briggs, W. M.
R64-32
Brinkman, K. A.
R62-11
Bristol, A.
R77-59
Brock, S. M.
R68-2 R68-3
Brohard, E.
R62-3
Brooks, D. B.
R66-1 R66-23 R68-3
R69-5 R70-1 R73-18
Brown, J. E.
R77-55
Brown, J. H.
R60-1 R62-4 R71-30
R73-19
Brown, R. W.
R74-114 R75-141
Brusca, H. J.
R72-70
Bryant, H. L.
R73-53
Bryson, N.
R78-3
Buchele, W. F.
R75-87
Buchholz, J.
R72-25
Buchman, N.
R75-78 R76-3 R76-4
Buehler, C. J.
R74-125
Bullis, R. A.
R73-174
Burner, C. C.
R73-20
Burton, J. D.
R67-9
Burton, L.
R73-21
Buscavage, J. J.
R65-1
Butch, D. L.
R71-2
Byrnes, W. R.
R58-3 R73-22

Caffrey, J. E.
R72-6
Caldwell, N. B.
R74-16
Calhoun, D.
R74-17 R76-96
Callaghan, D. J.
R76-15
Callahan, J. C.
R71-49
Callahan, J. G.
R71-49
Cameron, R. E.
R76-63
Camin, K. Q.
R71-3 R71-27 R72-43
Campbell, D. B.
R75-9
Camplin, P.
R65-12

# AUTHOR INDEX

Capp, J. P.
  R71-27 R71-30 R71-48
  R72-1 R72-19 R73-24
  R74-18 R74-73 R75-11
Carlin, D. F.
  R75-44
Carlozzi, C. A.
  R76-57
Carlson, B.
  R77-70
Carlson, C. G.
  R64-3
Carlson, R. O.
  R73-88 R75-37
Carlson, S.
  R74-9
Carr, E. A., Jr.
  R77-9
Carrel, J. E.
  R77-7
Caruccio, F. T.
  R73-26
Carter, R. P.
  R72-55 R73-25 R74-19
  R77-43
Carvey, K.
  R77-8
Caspall, F. C.
  R75-12 R75-86
Cecil, S. D.
  R76-41
Chadwick, M. J.
  R73-27
Chance, J.
  R78-3
Chapman, A. G.
  R44-2 R49-1 R67-14
Charmbury, H. B.
  R73-29
Charton, P.
  R77-9
Chase, P. E.
  R73-30
Cheasley, T. C.
  R50-;
Cherene, L. J.
  R76-16
Cherry, J. W.
  R63-8
Chironis, N. P.
  R71-4 R73-31 R74-21
  R74-22 R76-17 R77-10
  R77-11 R77-12 R77-13
Chrisman, H. H.
  R48-1
Clark, F. B.
  R54-1
Clark, W. F.
  R75-93 R75-109 R75-117
  R75-119 R75-121 R75-128
  R75-132 R75-133 R75-141
  R75-156
Clouston, J. B.
  R74-24
Coaldrake, J. E.
  R73-36
Coates, W. E.
  R73-37
Coe, D. A.
  R76-18
Coe, M. W.
  R72-8
Coenenberg, J. G.
  R78-4
Cole, N. F.
  R73-19
Cole, W. D.
  R72-12
Collier, C. R.
  R62-5
Collins, F. W.
  R56-7
Colvin, T. S.
  R75-87 R77-2 R77-6
  R77-14 R77-31
Connell, J. F.
  R75-49
Connell, J. P.
  R75-13
Contractor, D. N.
  R75-49
Conwell, C. N.
  R72-9 R76-23
Cook, C. W.
  R74-110 R76-96
Cook, F. X., Jr.
  R75-14 R76-24
Cook, L.
  R63-19

# AUTHOR INDEX

Coonan, G. R.
R75-15
Corbett, D. M.
R65-5 R65-6 R73-1
Cornforth, C. L.
R71-7 R73-38 R73-39
R73-40 R74-25 R74-26
R74-27 R74-28 R75-16
Cornwell, S. M.
R66-2 R68-4 R73-41
Cress, W. A.
R77-53
Croke, E. J.
R74-19
Crompton, E. J.
R74-96 R75-63
Crosby, E. C.
R77-16
Crouch, D. B.
R75-2
Crowl, J. M.
R57-3 R72-56
Crowley, R. H.
R75-10
Croxton, W. C.
R28-1
Culbertson, R. E.
R42-2
Cummins, D. G.
R65-7 R66-24
Cundell, A. M.
R77-17
Currier, W. F.
R73-42
Curry, J. A.
R73-169 R77-18
Curry, R. B.
R64-13
Curry, R. R.
R75-17 R75-88
Curry, W. J., III
R76-25
Curtis, W. R.
R71-8 R71-9 R71-10
R71-30 R72-11 R72-12
R73-43 R73-44 R74-68
R75-77 R77-19
Czapowskyj, M. M.
R66-3 R69-7 R70-4
R73-45 R76-26
Dale, M. E.
R61-4 R63-2
Daley, D. D.
R74-29
Dalrymple, B. W.
R65-8
Dalton, F. E.
R73-46
Danielson, V. A.
R69-21
Darmer, G.
R73-47
Davidson, W. H.
R68-5 R70-5 R72-13
R73-175 R77-20
Davies, W. M.
R61-3
Davis, G.
R62-6 R63-3 R64-5
R68-5 R72-13 R73-48
Davis, H.
R76-27 R77-21 R77-22
Davis, J. R.
R73-49
Davis, R. W.
R75-18
Davison, D. J.
R71-11 R75-19
Deane, J. A.
R66-4 R70-20
Deasy, G. F.
R60-3 R63-4 R64-4
R64-6
Decker, C. S.
R74-54
Deely, D. J.
R73-50 R73-51
Dein, J.
R73-5
Deitschman, G. H.
R48-1 R51-1
DeLong, T. S.
R57-2
DeMott, J. E.
R77-7
DenUyl, D.
R55-1 R62-14
DePuit, E. J.
R78-4

## AUTHOR INDEX

Despard, T. L.
  R74-31
DeTuerk, J. R.
  R68-9
Dials, G. E.
  R74-32
Dick, J. H.
  R75-90
Dickerson, J. A.
  R71-12
Dickman, I. I.
  R64-7
Dietrich, I. T.
  R73-176
DiGennaro, A. A.
  R74-112
Dillion, A. C., III
  R75-106
Dingus, G. P.
  R76-8
Dinkel, R. M.
  R68-16
Doering, E. J.
  R75-91
Dollhopf, D. J.
  R77-77
Doubleday, G. P.
  R74-113
Dougherty, M. T.
  R76-29
Doyle, W. S.
  R76-30
Draffin, C. W.
  R77-60
Drašković, D.
  R73-52
Dreese, G. R.
  R73-53   R75-21
Dressler, R. L.
  R75-68
Drnevich, V. P.
  R76-31
Drummond, S. E., Jr.
  R75-106
Duba, D. R.
  R77-23
Dubnie, A.
  R72-14
Dudley, T. E.
  R74-33   R75-92
Duggan, C.
  R73-132
Dunbar, F. C.
  R73-54
Dusek, G. L.
  R75-93
D[illegible]er, D. D.
  R72-18

Earl, T. A.
  R76-32
East, B.
  R67-1
Ebelhar, M. W.
  R77-68
Ebelhar, R. J.
  R76-31
Edgerton, B. R.
  R74-90   R75-94
Edwards, J.
  R72-43
Edwards, J. H.
  R47-3
Ehrle, E. B.
  R60-4
Eigenbrod, W. F.
  R71-30
Einspahr, D. W.
  R55-2   R55-6
Eisentrout, E.
  R71-48
Ellis, S. L.
  R77-23
Ellison, R. D.
  R76-96
Elzam, O. E.
  R74-34
Entzminger, R. A.
  R76-33
Erickson, L.
  R77-30
Etter, H. M.
  R70-12   R71-14
Evans, R. J.
  R75-5   R75-95
Everett, H. W.
  R74-48   R77-24

# AUTHOR INDEX

Falkie, T.V.
R70-6 R75-97
Fannin, P. J.
R73-56
Farmer, E. E.
R74-114 R75-141 R76-36
Farrand, E. P.
R64-12
Farrar, D. R.
R77-8
Fay, G.
R76-37 R76-41
Fenton, M. R.
R73-57
Ferko, M. R.
R73-141 R74-77
Ferraro, M.
R76-19
Filer, E. E.
R64-4 R64-41
Finch, T. E.
R77-25
Finney, J. H.
R62-8 R73-155 R77-82
Fischer, J. N.
R76-38
Fish, R.
R76-39
Fisser, H. G.
R75-23
Fitter, A. H.
R74-115
Fleming, A. L.
R74-116
Fletcher, K.
R76-96
Flowers, A. E.
R54-3 R55-3 R66-6
Foreman, J. W.
R75-44
Foreman, W. E.
R74-117 R76-40
Foresman, F. J.
R55-4
Foster, C. A.
R74-48
Fowler, D. K.
R73-58
Fox, S. D.
R48-2
Foy, C. D.
R74-116
Frank, R. M.
R63-5
Frawley, M. L.
R71-15
Frederick, G. B.
R71-30
Freeman, J. R.
R75-58 R75-101 R76-87
Freeman, P. G.
R73-188 R75-153
Frey, D. G.
R71-36
Friss, J. W.
R64-4
Fritz, E. L.
R77-45
Friz, T. O.
R76-51
Funk, D. T.
R61-4 R62-7 R63-6
R73-59 R78-12

Gaither, T. W.
R76-62
Galpin, S. L.
R48-3
Gantner, G. K.
R75-14
Garner, R. V.
R53-1
Gartner, E. H. E.
R69-13 R75-98
Gatrell, N.
R76-54
Gee, G. W.
R77-26
Gentry, C. E.
R65-7 R66-24
Geyer, W. A.
R70-19 R72-43 R73-60
Gifford, G. F.
R72-18
Gilley, J. E.
R77-26
Gillmore, D. W.
R72-1 R72-19 R73-24
R74-18 R75-11

# AUTHOR INDEX

Gillogly, L. E.
R64-32
Giorgetti, L.
R74-65
Glenn-Lewin, D. C.
R76-37 R76-41 R76-42
R77-8 R77-83
Glover, F. W., Jr.
R66-11 R71-30 R72-20
R76-43
Gold, D. P.
R73-5
Gold, R. S.
R75-83
Goldberg, E. F.
R72-21
Goodman, S. D.
R77-46
Goth, J. H.
R75-10
Gould, W. L.
R75-41 R75-99 R75-134
R77-59
Graham, H. D.
R48-4
Grandt, A. F.
R49-2 R58-2 R69-10
R71-27 R74-38 R76-44
R77-27 R78-5
Green, B. B.
R76-45
Green, J. E.
R75-100
Greenbaum, M. E.
R74-39
Greene, B. C.
R74-40
Greenwood, J. E.
R73-54
Griess, P. R.
R60-3 R63-4 R64-6
Griffith, F. E.
R66-7
Grim, E. C.
R72-22 R74-41 R75-104
Groenewold, G. H.
R75-121 R76-66
Gronhovd, G. H.
R75-153
Grubb, H. F.
R72-23
Grube, W. E., Jr.
R71-16 R73-61 R74-42
R74-88 R74-89 R75-58
R75-101
Gschwind, J.
R72-45 R73-104
Guckert, W. E.
R73-63
Guerke, M. L.
R78-2
Guernsey, L.
R55-7 R58-5 R59-7
R60-11 R61-12 R64-42
R67-15 R68-16
Gulliford, J. B.
R77-78
Gunnett, J. W.
R75-24
Gwynn, T. A.
R65-9 R66-8 R67-2
R69-11 R70-7 R73-177
R74-43

Hadley, R. F.
R76-52
Hagen, H. D.
R75-25
Haghiri, F.
R77-29
Haley, D. R.
R77-25
Haley, W. A.
R74-44 R76-46
Hall, G. F.
R77-28
Hall, J. G.
R63-15 R66-11
Hambleton, W. W.
R71-3 R71-27
Hamilton, L. W., Jr.
R74-45 R74-46
Hamon, W. R.
R77-29
Hanna, G. P., Jr.
R64-11
Hansen, R. P.
R76-96

# AUTHOR INDEX

- Harabin, Z.
  - R74-49
- Hardaway, J. R.
  - R77-30
- Hardin, N. C.
  - R71-30
- Hardy, R. G.
  - R71-3
- Harman, N. M.
  - R57-7
- Hart, G. E.
  - R58-3
- Hartman, H. L.
  - R69-13
- Hartman, R. T.
  - R73-2
- Harvey, C. E.
  - R74-39
- Hassell, W.
  - R76-96
- Haynes, R. J.
  - R72-28 R73-74 R75-102 R75-103
- Heald, M. T.
  - R74-47
- Heddelson, M. R.
  - R64-12
- Hedges, R. B.
  - R76-94
- Hedrick, H. G.
  - R56-3
- Heide, G.
  - R73-62
- Heine, W. N.
  - R73-63
- Hemish, L.
  - R75-121
- Hemsley, W. T.
  - R72-4
- Hendricks, C.
  - R72-71
- Henning, S. J.
  - R77-31
- Henry, D. S.
  - R77-24
- Hersman, L. E.
  - R77-32
- Hertsgaard, T. A.
  - R73-178
- Hickerson, H. C.
  - R75-26
- Hicks, D. R.
  - R76-56
- Higgins, T.
  - R73-64
- Hilbert, D.
  - R77-70
- Hill, L. W.
  - R60-5
- Hill, R. D.
  - R72-22 R72-58 R73-65 R74-41 R75-104 R76-47 R77-33 R77-34
- Hines, B. J.
  - R73-49 R74-48
- Hinesly, T. D.
  - R72-24
- Hinkle, K. R.
  - R77-34
- Hipwell, R. M.
  - R74-53
- Hodder, R. L.
  - R72-25 R72-26 R73-66 R75-105 R75-109 R76-96 R77-35
- Hoffman, F. M.
  - R76-62
- Hoffman, G. J.
  - R64-13
- Hofmann, L.
  - R77-36
- Holechek, J.
  - R75-119
- Holland, F. R.
  - R73-67
- Hollingsworth, J. A., Jr.
  - R64-14
- Holmberg, G. V.
  - R76-48
- Holzen, H. H.
  - R76-29
- Honkala, R. A.
  - R74-118
- Hooks, W. G.
  - R75-106
- Horton, J. O.
  - R73-68
- Howard, G. S.
  - R77-39

## AUTHOR INDEX

Howland, J. W.
R73-69 R73-70 R73-71
R75-28 R76-96
Hughes, T. H.
R75-106
Hungate, G. C.
R73-76
Hunt, J. W.
R64-15 R65-10
Hutnik, R. J.
R74-49 R77-46
Hyde, R. M.
R71-27 R74-110
Hyslop, J.
R64-16 R64-17 R72-27

Ibberson, J. E.
R57-2
Imhoff, E. A.
R76-49 R76-50 R76-51
R77-48
Immich, C.
R72-43
Ironman, R.
R74-50

Jackson, D., Jr.
R63-7 R75-108 R77-40
R77-41
Jacoby, H.
R73-73
Jacoby, P. W., Jr.
R68-6 R69-14
Janes, D. J.
R76-56
Jansen, I. J.
R77-42
Jasper, D.
R75-29
Jemison, G. M.
R65-11
Jencks, E. M.
R71-16
Jensen, I. B.
R75-109
Jewel, S. R.
R72-28 R73-74
Johnson, W.
R75-153
Jonáš, F.
R73-75
Jones, D. C.
R64-18 R71-19
Jones, E. B.
R75-110
Jones, J. N., Jr.
R72-69 R73-76 R75-30
R76-7 R76-13
Jones, J. R.
R74-51
Jones, R. L.
R72-24
Jones, W. G.
R59-4 R63-19 R64-43
R71-20 R71-21 R74-52
Jonescu, M. E.
R74-119
Joy, R. J.
R73-77
Jurgens, L.
R72-43

Kantner, D. A.
R73-3 R73-170
Kardos, L. T.
R72-62 R74-90 R74-120
R74-121 R75-94
Kathuria, D. V.
R75-43
Keefer, W. R.
R76-52
Keffler, C. A.
R69-13
Kelly, G.
R72-29 R74-120
Kelly, J. L.
R76-53
Kelly, W.
R76-24
Kennedy, A. S.
R73-25 R74-19 R77-43
Kerch, R. L.
R75-31
Kézdi, A.
R68-7
Khoury, S. G.
R74-53
Kieffer, F. V.
R72-72

# AUTHOR INDEX

Kimball, D. B.
R77-30
Kimball, R. L.
R66-7 R68-8
King, D. L.
R74-54
Kirkpatrick, J. C.
R75-32
Klimstra, W. D.
R59-5 R63-8 R64-29
R75-102 R75-103 R77-62
Kling, C. L.
R75-42
Klingensmith, R. S.
R77-34
Klutts, R.
R76-60
Knabe, W.
R64-19 R64-20 R73-79
Knight, C. G.
R76-54
Knochenmus, D.
R77-29
Knudsen, L. L.
R53-2
Knuth, W. M.
R77-45
Koehler, D. A.
R75-42
Kohl, E.
R70-20
Kolar, C.
R78-2
Kollman, A. L.
R75-153
Koppe, T. F.
R77-46
Kovacic, W. J.
R71-27 R72-43
Kowal, S. W.
R73-179
Kranz, B. W.
R74-55
Kraus, R.
R75-111
Krause, R. R.
R64-21 R70-8 R70-20
R72-73 R73-80 R73-81
R73-180
Kube, W. R.
R75-153
Kudrna, F. L.
R72-29 R73-181 R74-120
Kuhn, J. A.
R76-14
Kumar, P.
R77-47
Kunkle, S. H.
R72-32 R74-121

LaFevers, J. R.
R74-19 R76-51 R77-48
Laird, W. M.
R64-3 R64-4
Lamm, A. E.
R63-19 R64-4 R64-22
R69-15
Landis, R. C.
R73-54
Lang, A. L.
R58-2
Lang, R. L.
R71-23 R75-82 R75-112
R76-96
Laval, F. J.
R72-30
Lawrey, J. D.
R75-113 R77-49 R77-50
R77-51
Leathers, K. L.
R76-96
Leeson, D. E.
R74-112
Leistritz, F. L.
R73-178
Lejcher, T. R.
R72-31 R72-32 R73-82
R74-121
Leonard, J. W.
R74-66
Leuthart, C. A.
R75-114
Levene, H. D.
R71-24
Lewington, P.
R77-52
Light, B. A.
R75-34
Light, E.
R75-35

# AUTHOR INDEX

Limstrom, G. A.
  R49-3 R51-1 R60-6
  R63-9 R64-24
Lin, W. W.
  R75-146
Lindquist, A. E.
  R77-66
Lindsay, S. F.
  R77-30
Lindsey, D. L.
  R77-53
Livingstone, G. K.
  R75-36
Lockard, D. W.
  R77-66
Long, W. J.
  R74-2
Loomis, T. H. W.
  R70-9
Lorenz, R. J.
  R77-36
Loring, R. D.
  R48-5 R52-3
Lowry, G. L.
  R58-6 R61-5 R62-8
Lue-Hing, C.
  R74-70
Lujan, L. E.
  R66-9
Lundberg, P. E.
  R72-69 R77-54
Lusby, G. C.
  R76-55
Lusk, B. E.
  R73-83 R73-94 R74-57
Lyle, E. S., Jr.
  R76-56
Lynam, B. T.
  R75-37

Mac, See also Mc
MacGregor, I.
  R73-87
MacLauchlan, R. S.
  R75-38
Maddox, J. B.
  R77-55
Magnuson, M. O.
  R66-7 R68-8
Majerus, M.
  R73-136
Mallary, R.
  R76-19 R76-57 R77-56
Maloney, M. M.
  R41-1
Maneval, D. R.
  R72-33 R75-39 R75-40
  R76-58
Marley, S. J.
  R77-14
Marshall, L. C.
  R76-15
Martens, C. D.
  R74-64
Martin, K. R.
  R74-108
Martin, P. S.
  R76-86
Martinka, P. D.
  R69-13
Marx, D. H.
  R75-115
Mason, R. H.
  R75-116 R76-59 R77-57
Massey, H. F.
  R69-1 R72-34 R72-35
Masters, J.
  R76-60
Mathias, E. L.
  R77-54
May, M.
  R75-82
May, R. F.
  R63-10 R64-25 R65-31
  R67-3 R69-23
May, R. M.
  R42-2
Mays, D. A.
  R73-12 R73-13 R73-168
  R74-59

Mc, See also Mac
McBroom, H. R.
  R76-96
McCann, S. A.
  R75-117
McCart, G. D.
  R76-8
McCarthy, R. E.
  R73-84 R73-85 R75-118

# AUTHOR INDEX

McClain, P. M.
R76-88 R77-58
McClain, T. J.
R72-43
McComb, A. L.
R55-2
McCormack, D. E.
R74-58 R76-61
McCormick, L. H.
R73-86
McDermott, J. J.
R76-94
McElroy, A. D.
R76-60
McGinnes, E. A., Jr.
R78-12
McGrath, J.
R72-74
McKay, M.
R73-36
McKee, G. W.
R72-70
McKeever, I.
R66-10
McMillan, H.
R73-88
McNay, L. M.
R70-10 R75-14
McQuilkin, W. E.
R66-3
Medve, R. J.
R76-62
Medvick, C.
R71-50 R73-89
Mellinger, R. H.
R66-11
Melton, R. E.
R62-6 R63-3
Mengies, L.
R77-70
Merkel, D. L.
R74-60
Merz, R. W.
R49-3 R59-2
Meyn, R. L.
R75-119
Miernyk, W. H.
R71-26
Miles, V. C.
R73-90
Miller, E. L.
R68-9
Miller, J. H.
R73-22
Miller, R. C.
R76-46
Miller, R. M.
R76-63
Minear, R. A.
R77-16
Miyamoto, S.
R75-41 R77-59 R78-7
Moehller, J.
R76-96
Montague, A.
R76-47
Montgomery, E. H.
R74-17
Montgomery, H. B.
R62-9 R73-92
Montgomery, R.
R65-12
Moolick, R. T.
R72-38
Moomau, H. F.
R74-66
Moore, E. C.
R74-32
Moore, J. R.
R73-186 R74-13
Moore, R. T.
R75-42 R77-23
Moran, S. R.
R75-121
Morey, P.
R77-60
Morgan, R. L.
R73-182
Morning, J. L.
R74-65
Morse, H. H.
R64-32
Morton, P.
R73-93
Mulhern, J. J.
R73-83 R73-94
Müller, K.
R73-95
Mumford, R. E.
R73-96

# AUTHOR INDEX

Munn, R. F.
R73-97
Murphy, L.
R71-27
Murphy, R. R.
R73-46
Musaus, M. J.
R75-10
Musser, J. J.
R63-11 R70-2

Naughton, G. C.
R70-19
Nawrocki, M. A.
R75-43
Nawrot, J. R.
R77-62
Neebe, D. J.
R59-3
Nephew, E. A.
R72-40 R72-41 R75-44
R75-146 R76-64
Neumann, U.
R73-98
Nickel, R. E.
R75-125
Nickey, R. A.
R76-15
Nielsen, G. A.
R77-77
Noble, E. A.
R73-183 R76-66
Nock, M.
R76-3 R76-4
Nolden, C.
R76-67
Norton, B. E.
R72-18

Ogg, C. W.
R74-54
Olschowy, G.
R73-100
O'Neill, J. E.
R72-38
Orr, H. K.
R75-128 R77-65
Osterhoudt, F. H.
R74-67
Otte, J. A.
R75-45 R76-68 R76-69
Overton, D. E.
R77-16
Ozmina, D. J.
R71-30

Packer, P. E.
R74-114 R74-122 R75-141
Paller, W.
R73-102
Palmer, J. F.
R76-19
Paone, J.
R74-65
Parsons, J. D.
R64-26 R66-12
Pash, E. A.
R75-129
Paton, R. R.
R70-20
Patten, R. T.
R74-96 R75-63 R75-151
Patterson, D. D.
R76-70
Peck, Mrs. J. K., Jr.
R75-130
Pennington, D.
R75-46
Pense, R. A.
R71-28
Pentz, D. L.
R75-9
Perry, C. H., III
R73-58
Perry, E.
R76-71
Persse, F. H.
R77-66
Peterson, E. B.
R70-12
Peterson, J. R.
R72-45 R73-104 R74-70
Pettyjohn, W. A.
R73-30 R75-142
Phelphs, E. R.
R73-105
Pickering, R. J.
R70-2
Pietz, R. I.
R74-70

## AUTHOR INDEX

Plass, W. T.
R65-7 R66-12 R66-24
R67-4 R67-5 R67-6
R67-7 R67-8 R67-9
R68-12 R71-29 R71-30
R72-46 R72-47 R73-106
R73-107 R73-108 R73-109
R73-110 R73-111 R73-184
R74-71 R74-72 R74-73
R74-98 R74-107 R74-123
R75-47 R75-48 R75-49
R75-131 R76-72 R78-8
Powell, J. L.
R75-3 R77-67 R77-68
Powell, R. L.
R72-76
Power, G.
R72-21
Power, J. F.
R73-129 R73-132 R73-185
R76-73 R76-77 R76-78
R77-36 R78-9 R78-11
Poyser, R. W.
R75-2 R76-75
Preate, E. D., Jr.
R72-48 R75-130
Proctor, K.
R73-136
Pundari, N. B.
R75-51
Pursell, C. F.
R78-2

Rahn, P. H.
R75-133
Rai, D.
R75-41 R75-99 R75-134
Raivio, H. A.
R73-174
Ralston, S.
R77-70
Ramani, R. V.
R73-141 R74-77 R74-92
Randolph, D.
R76-69
Raney, W. B.
R74-40
Rankin, B.
R66-14 R67-10
Rauzi, F.
R77-39
Rawson, J. W.
R71-30
Ray, J. R.
R72-77
Reavis, J. L., Jr.
R74-124
Reber, N. F.
R73-116
Rechard, P. A.
R75-135
Reddy, N. N.
R74-125
Redente, E. F.
R76-75
Reed, L. A.
R75-52
Reid, J. S.
R74-80
Reilly, J. D.
R72-51
Reiss, I. H.
R73-120 R74-81 R74-82
R74-83 R77-74
Renney, C. W.
R73-77
Ricca, V. T.
R72-64
Richardson, B. Z.
R74-114 R75-141 R76-36
Richart, F. W.
R44-1
Richter, D. E.
R70-20
Rickard, D.
R65-16
Riecken, F. F.
R55-2
Ries, R. E.
R75-23 R75-132 R76-73
R76-77 R76-78 R77-36
R78-9
Riley, C. V.
R47-4 R52-4 R54-4
R57-8 R60-7 R63-14
R72-54 R73-122 R73-123
R73-124 R74-85 R76-79
Rink, G.
R74-98

# AUTHOR INDEX

Roberts, J. R.
R74-86
Robertson, D. R.
R75-54
Robins, J. D.
R72-30 R76-80
Roe, P. A.
R73-36
Rogers, N. F.
R51-2 R78-12
Rogers, R. H.
R75-142
Root, J. D.
76-81
Roseberry, J. L.
R62-10 R64-29
Rossin, A. D.
R72-55
Rosso, W. A.
R77-76
Rothwell, F. M.
R73-126
Ruble, R. W.
R64-12 R73-90
Rudolph, E. D.
R75-113
Ruffner, J. D.
R63-15 R73-127 R73-128
R78-10
Ruhr, C. E.
R51-4
Rush, E. S.
R76-82
Russell, O. R.
R73-51 R73-161
Ryder, P. D.
R72-23
Ryerson, D. E.
R72-25

Sanders, S. A.
R77-24
Sandoval, F. M.
R73-129 R73-185 R75-132
R75-154 R76-73 R76-77
R76-78 R78-9 R78-11
Saperstein, L. W.
R70-6 R73-130 R73-131
Sappenfield, V.
R47-1 R56-4
Sauer, E. L.
R62-15
Sauer, R. H.
R75-143
Sawyer, L. E.
R42-1 R46-2 R47-2
R49-9 R54-5 R62-16
R66-16 R66-26 R67-17
R69-17 R69-18 R69-26
R72-56
Scanlon, D. H.
R73-132
Schafer, W. M.
R77-77
Schaffer, R. B.
R75-55
Schessler, T. E.
R64-30
Schlätzer, G.
R73-133
Schlottmann, A.
R76-83
Schmelz, D. V.
R72-8
Schmidt, J.
R77-30
Schmidt, R. A.
R72-57
Schmidt-Bleek, F. K.
R73-186 R74-13
Schoewe, W. H.
R60-8
Scholl, D. G.
R76-84
Schroer, F. W.
R76-85
Schuller, W. A.
R76-87
Schultz, D. A.
R73-102
Schultz, D. T.
R75-78 R76-3 R76-4
Schulze, W. L.
R73-134
Schuman, G. E.
R77-39
Schwab, G. O.
R64-13
Schwartz, J. W.
R74-116

# AUTHOR INDEX

Scott, M. D.
R75-56
Scott, R. B.
R72-58
Seastrom, P. N.
R63-16 R64-4 R64-41
Secor, E. S.
R73-130 R73-131 R74-112
Sedgley, E. F.
R74-87
Seidel, K. W.
R61-8 R62-11
Seith, R. T.
R75-32
Seitz, W. D.
R72-59 R74-127
Selner, J. E.
R75-57
Sencindiver, J. C.
R74-89
Sendlein, L. V. A.
R77-78
Shaffer, S. L.
R74-12
Shanholtz, V. O.
R75-49
Sharma, K.
R77-47
Shigo, A. L.
R78-12
Shillabeer, J. H.
R76-86
Shrader, W. D.
R55-2
Simchuk, G. J.
R72-61
Simmler, J. J.
R74-54
Simpson, D. G.
R75-11
Sims, P. L.
R74-110
Sindelar, B. W.
R72-25 R72-26 R73-136
Singh, R. N.
R71-16 R73-61
Singhal, R. K.
R70-14
Sitterley, J. H.
R64-31
Skawina, T.
R75-144
Slack, J.
R73-137
Slayback, R. D.
R73-77
Smith, D.
R76-1
Smith, H. G.
R64-32
Smith, R. M.
R45-1 R48-3 R71-16
R71-30 R71-35 R73-61
R73-138 R74-42 R74-47
R74-88 R74-89 R75-58
R76-87
Smith, R. W.
R71-36
Smith, W. D.
R71-30
Sobek, A. A.
R73-61 R74-88 R74-89
R76-87 R77-85
Sobitsky, V.
R69-13
Soine, G.
R70-20
Sopper, W. E.
R70-15 R71-37 R72-62
R74-90 R74-120 R74-121
R75-94
Sosewitz, B.
R72-24
Sowa, E. A.
R73-175
Sowards, W. E.
R75-2 R75-68 R76-2
Spaulding, W. M., Jr.
R68-1
Speake, C. J., Jr.
R77-25
Sperow, C. B., Jr.
R71-30
Spore, R. L.
R75-44 R75-146 R76-64
R76-83
Springfield, H. W.
R73-171 R75-75 R76-2
R77-1

# AUTHOR INDEX

Stamm, G. G.
R75-59
Stauffer, B. E.
R76-88
Stearn, E. W.
R64-33
Stefanko, R.
R73-141 R74-77 R74-92
Stein, J.
R73-142
Steiner, D. E.
R74-7
Steiner, W. W.
R73-128
Stevens, C. A.
R77-79
Stewart, E. L., Jr.
R72-43
Stimpson, B.
R76-89
Stiver, E. N.
R49-4 R49-5
Stollman, I.
R61-9
Stone, E. L.
R68-4 R73-41
Stoneman, W. C.
R72-57
Straub, F.
R65-17
Streib, D. L.
R77-85
Striffler, W. D.
R73-143
Struthers, P. H.
R53-2 R60-9 R61-10
R64-34 R65-20 R65-21
Strzyszcz, Z.
R74-49
Sullivan, G. D.
R63-18 R63-19 R64-4
R65-22 R65-35 R67-12
Sundberg, E.
R75-119
Superfesky, M. J.
R78-13
Sutton, P.
R70-16 R70-21 R71-30
R71-43 R73-146 R73-147
R73-148 R73-155
Swanson, E. R.
R73-149
Swift, D.
R77-70
Syvertsen, E. M.
R76-93

Taff, H. A.
R64-36
Taiganides, E. P.
R72-64
Tarbox, G. L., Jr.
R54-6
Teague, R. N.
R72-79
Thames, J. L.
R74-96 R75-63 R75-147
R75-150 R75-151 R76-95
R77-1 R77-27 R77-35
R77-43 R77-81
Thirgood, J. V.
R71-45 R73-150 R75-90
Thompkins, D. C.
R73-151
Thompson, W. W.
R69-19
Thor, E.
R74-98
Thornburg, A. A.
R74-99
Tilmann, W.
R72-65
Tixier, J. S.
R75-64
Tobler, R. H.
R75-65
Toy, T. J.
R76-55
Tresler, R. L.
R74-101
Trimble, G. R., Jr.
R63-20
Triner, E. D.
R56-6
Truax, C. N., Jr.
R65-23
Tryon, E. H.
R60-1 R71-35
Tschantz, B. A.
R73-152

# AUTHOR INDEX

- Tuma, G.
  - R76-96
- Tung, H.-S.
  - R75-149
- Tyner, E. H.
  - R45-1 R48-3 R71-35

- Underwood, R. C.
  - R75-125

- Vaden, J. H.
  - R64-1
- Vande Linde, O. V., Jr.
  - R71-30
- VanLandingham, A. H.
  - R65-24
- Van Lear, D. H.
  - R71-46
- Van Voast, W. A.
  - R74-104 R76-94
- Verma, T. R.
  - R75-147 R75-150 R75-151
  - R76-95 R77-81
- Verts, B. J.
  - R56-5 R56-8 R57-9
  - R59-6
- Vimmerstedt, J. P.
  - R65-20 R65-21 R70-22
  - R73-148 R73-155 R77-82
- Vogel, W. G.
  - R68-15 R71-30 R71-47
  - R73-16 R73-111 R73-156
  - R73-157 R74-105 R75-66
  - R75-69
- Vohs, P. A., Jr.
  - R62-12 R63-8
- Voight, J. R.
  - R76-42 R77-83
- VonDemfange, W. C.
  - R75-67
- Vories, K. C.
  - R76-96
- Voysey, J. C.
  - R61-11

- Wahlquist, B. T.
  - R75-68 R76-97
- Wali, M. K.
  - R73-172 R73-176 R73-177
  - R73-178 R73-182 R73-183
  - R73-185 R73-188 R75-75
  - R75-84 R75-88 R75-90
  - R75-97 R75-99 R75-105
  - R75-112 R75-118 R75-147
  - R75-152 R75-153 R75-154
  - R75-155
- Walker, D. E.
  - R69-13
- Walsh, J.
  - R65-26
- Warner, D. L.
  - R75-67
- Watts, J. P.
  - R77-84
- Weber, L. S.
  - R62-13 R66-28 R71-52
- Weigle, W. K.
  - R65-28 R66-21 R68-14
- Weimer, W. A.
  - R69-13 R73-158
- Weimer, W. H.
  - R72-66 R73-158
- Weingartner, D. H.
  - R76-56
- Weiss, N. E.
  - R77-85
- West, L. J.
  - R76-89
- Wheeler, O. E.
  - R74-106
- Wheeler, W. H.
  - R76-98
- Whincup, G. T.
  - R72-67
- Whitby-Costescu, L. M.
  - R76-86
- White, D. H.
  - R69-21
- White, J. R., Jr.
  - R74-107 R75-106
- White, R. L.
  - R75-155
- Whitt, D. M.
  - R70-23
- Wier, C. W.
  - R73-161

## AUTHOR INDEX

Wierenga, P. J.
R75-99 R75-134
Wilkinson, J. L.
R73-162
Williams, G. P., Jr.
R68-14 R73-163 R76-31
R78-13
Williams, R. L.
R73-18
Willis, W. O.
R73-129 R73-185 R75-91
R75-132 R76-78 R77-26
Willmuth, W. H.
R78-4
Willoughby, W. E.
R76-82
Wilmoth, R. C.
R72-58
Wilson, H. A.
R56-3 R57-5 R71-16
Winchell, J. H.
R48-6
Wiram, V. P.
R77-86
Wobber, F. J.
R73-51 R73-161 R73-164
R74-108
Wolcott, B. H., Jr.
R75-69 R77-76
Wyatt, O. D.
R55-5

Yamamoto, T.
R75-70 R75-156
Yeager, L. E.
R42-3
Young, R. A.
R77-26
Youngs, B. D.
R73-165 R73-166

Zacher, F. R.
R74-66
Zajac, Z.
R75-157
Zande, R. D.
R73-167
Zarger, T. G.
R66-22 R73-12 R73-168
R73-169
Zellmer, S. D.
R74-19 R76-45
Zillman, R. L.
R73-189
Zimmerman, R. E.
R72-55 R73-25 R77-43
Zube, E. H.
R76-19
Zwight, D. M.
R77-7

# GENERAL INDEX

Acid mine drainage (See also Runoff from spoil)
  Maryland, abandoned strip mines
    R73-187
Acid spoil (See also Spoil acidity)
  effects
    R74-116
  Perry County, Ohio
    R75-113
    on germination of grass seed with fertilizer
    R77-55
Ackenheil & Associates, Inc., Pittsburgh, Pennsylvania
  R76-29
Advance surface mining
  R72-66
Adventure Coal Company, Kettle Island, Kentucky
  R66-5
Aerial photography (See also Remote sensing techniques)
  R73-9 R75-26
  color
    R77-45
  photogrammetry, estimating amounts of coal and overburden
    R76-18
  surveys
    Alabama
    R75-106
    Northern Great Plains
    R76-91
  vegetative cover measurement
    R77-7
Aerospace Corporation, El Segundo, California
  R76-33
Aesthethics of reclaimed land (See also Reclamation planning)
  R76-57 R77-13
Agricultural crops; See Farming
Agricultural Research Service, U.S. Department of Agriculture (See also North Appalachian Experimental Watershed; Northern Great Plains Research Center; Plant Stress Laboratory)
  R72-69 R75-30 R76-7 R76-13
  Morgantown, West Virginia
    R77-54
Agricultural water needs, models
  R76-53
Agriculture, U.S. Department of; See Agricultural Research Service; Cooperative States Research Service; Forest Service; High Plains Grasslands Research Station; Northern Great Plains Research Center; Science and Education Administration; Soil Conservation Service
Air and Water Programs, Office of, U.S. EPA
  R73-114
Airport Expansion
  R67-13

# GENERAL INDEX

Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama
  R76-56
Alabama legislation
  R75-25
Alabama reclamation (See also Soil characteristics; Tree establishment; Vegetation on spoil banks)
  R73-168
    and mining, aerial survey
      R75-106
Alabama surface mining
  R72-63   R73-125
Alabama Surface Mining Reclamation Council
  R74-25
Alabama, University of,
    Department of Geology and Geography
      R75-106
Alaska surface mining and reclamation
  R72-9   R72-53   R76-23
Alberta, Canada
    reclamation
      R70-12   R71-14   R75-57   R77-47
    vegetation on spoil banks
      R76-81
Alberta Research Council, Edmonton, Alberta, Canada
  R76-81
Alberta, University of, Edmonton, Alberta, Canada
  R76-89
Alder trees
  R61-11
Alkali sacaton
  R73-4
Allis-Chalmers Corporation, Milwaukee, Wisconsin
  R73-179
Alluvial valley floors
  R77-30
Aloe Coal Company, Imperial, Pennsylvania
  R71-42
Aluminum toxicity
  R74-116
AMAX Coal Company, Indianapolis, Indiana (See also Ayshire Coal Company; Meadowlark Farms, Inc.)
  R75-31
    Belle Ayr Mine, Gillette, Wyoming
      R74-28   R75-70   R75-128
    Catlin Mine
      R74-3
    SOAP (Soil Overburden Analysis Program) and Hydrology program
      R77-86
Ambionics, Inc., Washington, D.C.
  R74-84

# GENERAL INDEX

American Metal Climax, Inc. (See also AMAX Coal Company)
   R73-87
Anthracite spoils
   R63-5  R66-3
      vegetation on (See also Tree establishment, Pennsylvania)
         R66-2
Anthracite surface mining and reclamation
   R65-10  R68-9  R75-22  R76-54
Appalachia (See also names of Appalachian states; Vegetation on reclaimed mined land)
      reclamation
         R71-28  R74-10  R75-22  R76-57  R78-8
         costs
         R75-146
      revegetation projects
         R73-109
      surface mining
         R66-19  R67-1  R68-1
Appalachian Regional Commission, U.S. Government
   R66-19  R73-7  R73-55  R74-30  R74-93  R74-111
   R75-136  R75-138  R75-139  R75-140  R75-145  R76-58
      revegetation manual
         R75-137
Appalachian Regional Development Act of 1965
   R65-14
Apple trees
   R64-9
Arch Mineral Corporation, St. Louis, Missouri
      Seminoe No. 1 Mine, Hanna, Wyoming
         R77-39
Area mining, Kentucky
   R74-111
Argonne National Laboratory, Argonne, Illinois
      Center for Environmental Studies
         R72-55  R73-25  R74-19
      Energy and Environmental Systems Division
         R76-45  R77-43  R77-48
         Land Reclamation Program
         R76-63
            bibliography
               R77-85
            review
               R78-6
Arid land reclamation (See also Black Mesa, Arizona; Montana reclamation; Surface manipulation for moisture retention; Water harvesting; Western United States; Wyoming reclamation)
   R70-13  R72-18  R73-4  R73-77  R74-60  R75-109

## GENERAL INDEX

Arizona, University of, Tucson
R74-96 R75-63 R76-38 R76-53
Department of Range Management
R75-150
School of Renewable Natural Resources
R75-151 R76-95
Army Corps of Engineers, U.S. Government; See Corps of Engineers, U.S. Army
Arnot bristly locust
R71-4
Atlantic Richfield Company, Los Angeles, California
Powder River Basin, Wyoming
R75-23
Attitude survey
mining and reclamation in Ohio
R72-77
mining regulation
R74-125
Auger mining
R74-124
Australia (See also Bibliographies, CSIRO)
mining
R69-13 R72-61 R75-9
reclamation
R77-73
Ayrshire Coal Company (See also AMAX Coal Company; Meadowlark Farms, Inc.)
R63-12 R69-20 R71-22

Backfilling methods
R66-7
contour, multiple seams, steep slopes
R74-2 R77-18
with coal refuse
R69-21
Backhoes
R75-4
Michael Baker, Jr., Inc.
R73-7
Theodore Barry & Associates, Los Angeles, California
R76-15
Base-line studies
Powder River Basin, Wyoming
R75-23
Battelle Memorial Institute, Columbus, Ohio
R74-15
Bear Branch Creek, Kentucky
R71-2 R73-43
Beaver Creek, Kentucky
R62-5 R63-11 R64-11 R70-2
Beech trees
R73-73

## GENERAL INDEX

- Bench method of mining
  - R72-66
- Bendix Aerospace Systems Division, Ann Arbor, Michigan
  - R75-142
- The Bendix Corporation, Southfield, Michigan
  - R73-30
- Bermudagrass
  - R77-54
- Berries (See also Elderberries)
  - R74-12
- Bibliographies
  - R61-1 R62-7 R64-13 R71-15 R72-72
  - R72-60 R73-97 R73-151 R75-100 R76-26
  - Argonne National Laboratory
    - R77-85
  - CSIRO, Australia
    - R73-36
  - Iowa State University
    - R76-41
  - Minnesota, University of, Forestry Library
    - R76-1
  - Northeastern Forest Experiment Station, Surface-Mined Area Restoration Research Project
    - R74-16
  - western United States, mined lands
    - R70-3 R72-18 R74-118 R77-70
- "Big blade"
  - R73-21 R73-71
- Big Horn Coal Company, Omaha, Nebraska
  - Big Horn Mine, Sheridan, Wyoming
    - R70-13 R76-55
- Big Muskie
  - R69-4
- Big Sandy River, Kentucky
  - R74-93
- Birds on surface-mined land
  - R58-1
- Bituminous Coal Research, Inc., Monroeville, Pennsylvania
  - R74-37
- Black locust trees
  - R60-1 R72-47 R73-157
- Black Mesa, Arizona
  - R75-147 R75-150 R75-151 R76-53 R77-81
  - multiple land use with water harvesting
    - R76-95
- Black walnut trees
  - R61-8 R62-11 R78-12
  - Kansas
    - R70-19

# GENERAL INDEX

Block-cut method of mining
R73-31 R73-63 R73-130 R73-131
Bobwhite quail
R62-12
Box-cut method
R70-8 R72-66 R74-97
British Columbia, Canada (See also Elk River Coal Field; Fording Coal Ltd.)
reclamation
R71-25 R75-36 R75-90
and legislation
R71-45
British reclamation; See Great Britain, reclamation
Browsed pines
R70-5
Bucket-wheel excavator
R75-83
Bucyrus-Erie Company, South Milwaukee, Wisconsin
R64-14 R74-106
Buffalo Coal Company, Ba[illegible], West Virginia
R76-34
Buffalo Mining Company; See The Pittston Company
Bureau; See other part of title
Burgess Mining & Construction Corporation, Birmingham, Alabama
R72-63
Busseron Creek, Indiana
R73-1
By-products of coal mining, recovery of limestone, clay, and shale
R64-18

CH2M Hill, Inc., St. Louis, Missouri
R76-93
C & K Coal Company, Clarion County, Pennsylvania
R74-64
Cabin Creek, West Virginia, demonstration project
R73-23 R74-7
Camp sites (See also Recreation)
R67-10 R68-10
Campaign Clean Water, Charleston, West Virginia
R75-35
Canada (See also Alberta; Alberta, University of; British Columbia; Cape Breton Development Corp.)
Department of Energy, Mines and Resources, Mining Research Laboratories
R76-86
legislation
R76-86
surface mining and reclamation
R69-3 R72-14 R73-139 R75-9
Canadian geese
R69-6

# GENERAL INDEX

Cannelton Industries, Inc.
  R73-93  R74-10
Cape Breton Development Corporation, Alder Point Mine, Nova Scotia
  R74-80
Caperton Coal Co., Hazard, Kentucky
  R64-9
Capital Fuel, Inc., West Virginia
  R72-7
Carbon-dioxide-producing microbes in spoil
  R56-3
Caribou National Forest, Pocatello, Idaho
  R73-102
R. S. Carlin, Inc., Snow Shoe, Pennsylvania
  R63-17
Caterpillar Tractor Company, Peoria, Illinois
  R74-44  R76-46
Central Ohio Coal Company
  R69-4  R69-13
Central Pennsylvania Open Pit Mining Association
  R59-4
Central Research and Design Institute for Opencast Mining, POLTEGOR, Poland
  R74-109  R76-11  R77-5
Central States Forest Experiment Station, U.S. Department of Agriculture
  R44-2  R49-1  R49-3  R51-1  R51-2  R54-1  R59-2
  R59-3  R60-5  R60-6  R61-4  R61-8  R62-7  R62-11
  R63-2  R63-6  R63-10  R65-7  R65-28
    program review
      R64-25
Charles River Associates, Inc., Cambridge, Massachusetts
  R73-55
Chicago Prairie Plan (See also Sewage as fertilizer; Metropolitan Sanitary District of Greater Chicago)
  R72-29  R73-46  R73-181  R74-120  R74-127  R76-60
Christopher Coal Company, West Virginia; See Consolidation Coal Company
Clarion State College, Pennsylvania
  R73-2
Clear Creek Swamp, Webster and Hopkins Counties, Kentucky
  R75-114
Coal, estimating amount of
  R76-18
Coal Research, Office of, U.S. Department of the Interior
  R73-141
Collins Mining Company, Hanging Rock, Ohio
  R64-15
Cologne Lignite District
  R73-9
    fauna on spoil
      R73-98
    vegetative studies
      R73-10

# GENERAL INDEX

Colorado legislation
R76-20 R76-49
Colorado reclamation (See also Vegetation on spoil banks)
R65-4 R75-42 R75-84 R75-116
Colorado shale-oil waste characterization
R77-17
Colorado State University, Fort Collins, Colorado
Natural Resource Ecology Laboratory
R77-70
Range Science Department
R74-110
Computer generation of monthly production reports
R75-26
Computer graphics in reclamation planning
R77-56
Conference on Reclamation of Surface-Mined Lands for Outdoor Recreation
Proceedings digest, Mid-Atlantic Regional Conference
R73-112
Proceedings First National Conference
R73-101
Proceedings Lake Central Region Conference
R73-113
Conference on Surface Mining, called by the Council of State Governments, held at Roanoke, Virginia, April 13, 14, 1964
R64-4 R64-35
Congress of the United States; See House of Representatives; Senate
Conifers
R58-6
Conotton Creek subwatershed, Carroll and Tuscarawas Counties, Ohio
R74-112
Consolidation Coal Company
R66-14 R66-20 R71-6 R72-15 R75-148
Christopher Coal Company Division
R65-2 R75-34
Hanna Coal Company Division
R61-2 R61-7 R64-23 R64-39 R64-44 R65-15
R69-9 R69-12 R71-31
Mountaineer Coal Company Division
R73-34
Truax-Traer Coal Company Division
R47-3 R56-5 R56-6 R70-18
Western Region
Glenharold Mine, Stanton, North Dakota
R75-132 R76-21 R76-22 R76-73
Roundup, Montana
R75-93
Container-grown seedlings
R73-175 R77-46
Contour mining, Kentucky
R74-111

# GENERAL INDEX

Contrary Creek, Louisa County, Virginia
    Demonstration Project
        R77-34
Controlled placement of spoil (See also Valley fill; Mountaintop removal)
  R71-39    R74-40
Cooperative States Research Service, U.S. Department of Agriculture
  R77-3    R77-77
Cornell University, Ithaca, New York
  R66-2
Corps of Engineers, U.S. Department of the Army
  R72-60    R73-23
    Mobility and Environmental Systems Laboratory, Vicksburg, Mississippi
        R76-82
Corsican pine
  R61-11
Cost analyses of model mines (See also Mathematical model, costs of mining and reclamation)
  R72-10
Costain Mining, Ltd., United Kingdom
  R57-4
Cost-benefit analysis
  R66-23    R68-2    R68-3    R69-5
    steep slope mining, Tennessee
        R74-13
    surface mining in Appalachia
        R73-186
Costs of parting handling
    mathematical model
        R77-25
Costs of reclamation
  R54-3    R62-15    R65-19    R68-16    R73-7    R73-18    R73-35
  R75-5    R77-6
    Appalachia
        R75-146
    Appalachian and Midwestern Coal Supply Districts
        R75-95    R76-64
    earth handling
        R73-69    R73-70    R73-174
    Elkins, West Virginia, demonstration project
        R72-58
    Iowa Coal Project
        R77-2
    Knife River Coal Company, Bismarck, North Dakota
        R73-177
    mathematical model
        R75-146    R76-68
      Illinois
        R77-43
      legislative requirements
        R74-117    R76-40

Costs of reclamation (continued)
    Pennsylvania
        R75-60
    western United States
        R76-96 R77-66
Costs of regulating mining
    Federal legislation
        R75-51
    Pennsylvania legislation
        R76-25
Costs of surface mining (See also Multiple seam mining)
  R72-51 R72-66 R73-35 R74-32 R75-8 R75-44 R75-45
    Appalachia
        R76-64
    auger and longwall
        R74-124
    Illinois, Knox and Fulton Counties
        R48-4
    mathematical model
        R76-68 R76-69
Council for Surface Mining and Reclamation Research in Appalachia
        R74-37
Council of Planning Librarians
    bibliography
        R75-100
Cross-ridge mining
        R76-17
Crownvetch
  R61-2 R61-7 R63-15 R64-39 R64-44 R72-70
Cumberland River, Kentucky
  R74-93
Czechoslovakia, reclamation
  R73-75

DLM Coal Company, Buckhannon, West Virginia
  R76-74
Dames & Moore, Billings, Montana
  R76-89
    Denver, Colorado
        R76-28
    Toronto, Canada
        R76-86
Decker Coal Company, Omaha, Nebraska
    Decker, Montana, mines
        R72-26 R74-104 R74-114 R75-141
        Decker Mine
        R76-36
        Tongue River Mine
        R75-89

Denmark, reclamation
  R73-133
Dents Run Watershed, West Virginia
  R75-34
Denver Service Center, Bureau of Land Management, U.S. Department of the Interior
  R70-3 R70-9
Denver, University of, Denver, Colorado
    Department of Geography
      R76-55
Desert Arboretum, Kibaek, Denmark
  R73-133
Disposal of solid wastes in sanitary landfills
    Maryland, abandoned strip mines
      R73-187
Drainage control
  R77-6

ERT Ecology Consultants, Inc., Fort Collins, Colorado
  R75-42 R76-96 R77-23
Earth moving equipment; See Machinery for mining and reclamation
Earth Satellite Corporation, Washington, D.C.
  R71-34 R72-49 R73-164
Earthworms, in Ohio spoils
  R77-82
Eastern Kentucky University, Richmond, Kentucky
  R71-2 R75-138 R75-139 R75-140
Eastern Ohio Resources Development Center
  R70-21
Economic effects of legislation (See also Economic forecasts)
  R75-21
    Ohio
      R73-53
Economic effects of surface mining and reclamation (See also Socio-economic effects)
  R64-17 R66-1 R75-22 R75-24
    Alabama
      R75-25
    West Virginia
      R71-26
Economic forecasts
  R72-44 R73-54 R73-55
Economics; See Costs
Education; See Reclamation technology training
El Paso Natural Gas Company, Houston, Texas
  R75-134
Elderberries
  R65-15

## GENERAL INDEX

Elk River Coal Field, British Columbia, Canada
   R76-16
Elkins, West Virginia, demonstration project
   R73-65
      costs
         R72-58
Energy Coal Company, Colorado
   R65-4
Energy Fuels Corporation, Steamboat Springs, Colorado
   R75-116
Energy production affected by surface mining for coal
   R71-18
Energy Research and Development Administration, U.S. Government
   R77-60
Energy, U.S. Department of
   R77-85    R76-8
Enos Coal Mining Company, Oakland City, Indiana
   R62-1
Environmental Impact Statements
   R76-93
Environmental Protection Agency, U.S. Government (See also Air and Water Programs, Office of; Industrial Environmental Research Laboratory; National Environmental Research Center, Cincinnati, Ohio; Research and Development, Office of; Research and Monitoring, Office of; Solid Waste Management Programs, Office of; Water Programs, Office of; Water Quality, Office of)
   R76-47
      Region VIII, Denver, Colorado
         R76-91    R77-30
Erosion and sedimentation (See also Drainage control; Sediment ponds; Water quality, turbidity control)
   R71-8    R73-43    R74-68    R75-35
Erosion, by simulated rainfall
   R77-26
Erosion control
   R71-9    R71-10    R73-52    R73-184    R75-10    R75-52    R75-105
   R76-98
Erosion measurement
   R72-12    R75-32
      photographic technique
         R75-77
European alder trees
   R61-4    R73-59
      as a nurse crop
         R63-2
Excavators
   R76-34

# GENERAL INDEX

Falcon Coal Company, Lexington, Kentucky
    Breathitt County Operations, Jackson, Kentucky
        R75-61    R77-57    R77-79
    Hazard, Kentucky
        R75-96
Farming (See also Forage crops; Grazing intensity; Maid Marion Farms; Meadowlark Farms, Inc.; Pastures; Vineyards)
    R71-22    R71-27    R73-64    R77-52
    beef cattle
        R77-9    R77-74
    Illinois
        R47-3    R66-18    R75-86    R77-42
    Indiana, Vigo County, farm land decrease
        R55-7    R61-12
    row crops
        R77-31    R77-42
    truck gardens
        R76-35
    wheat yields
        R76-22
Fauna on spoil, Cologne Brown Coal District
    R73-98
Federal coal leasing
    R74-9    R75-65
Federal land reclamation
    R72-2
    policy
        R75-97
Federal legislation
    Appalachian Regional Development Act of 1965
        R65-14
    costs resulting from
        R75-51
    effects of
        R74-4
    Federal Water Pollution Control Act, Oct. 18, 1972
        R75-55
    Ford Foundation Study
        R74-14
    statements on proposed bills
        R73-8    R73-87    R73-91    R73-93    R73-105    R73-137
        R73-162
Fertilizers (See also Sewage as fertilizer)
    R73-168    R75-66
    effect on grass seed germination in acid spoil
        R77-55
    requirement (See also Nitrogen --; Phosphorus --; Potassium --)
        western lands
            R75-119

Fertilizers (See also Sewage as fertilizer) (continued)
  timing of application
    R73-12 R73-13
Finite element analysis
  R74-106
Finn Equipment Company, Cincinnati, Ohio
  R73-134
Fish and fishing affected by surface mining
  R65-80 R67-1 R68-1 R68-10 R70-13 R71-2
Fish and Wildlife Service, U.S. Department of the Interior
  Western Energy & Land Use Team
    R77-70
Fish in surface-mine ponds
  R58-4
Fishery management in surface-mine ponds
  R51-4 R73-20
Fishing in surface-mine ponds
  R65-34
Flooding, affected by surface mining
  R77-19
Fluor Utah, Inc., San Mateo, California
  R77-60
Fly ash as spoil amendment
  R71-27 R71-48 R72-1 R72-3 R72-19 R72-43 R73-24
  R73-99 R74-18 R74-73 R75-11 R76-29 R77-39
Forage crops
  R45-1 R74-59
  Kentucky
    R77-24
  perennial species, effects of sodium and magnesium on survival and growth
    R76-78
  Virginia
    R76-8
Ford, Bacon & Davis, Inc., Engineers, New York, New York
  R74-30 R74-111 R75-14 R76-17
Ford Foundation
  Energy Policy Project
    R74-126
Fording Coal Ltd., Calgary, Alberta, Canada
  Fording River mine, Elkford, British Columbia, Canada
    R76-39
Forest Service, U.S. Department of Agriculture (See also Central States Forest Experiment Station; Intermountain Forest and Range Experiment Station; North Central Forest Experiment Station; Northeastern Forest Experiment Station; Palzo site; Rocky Mountain Forest and Range Experiment Station; Shawnee National Forest)
  R63-9 R67-9 R73-82 R74-62 R74-100 R74-107
  Eastern Region
    R62-2 R64-30

Forest Service, U.S. Department of Agriculture (continued)
    Surface Environment and Mining (SEAM) Program
        R76-33
Forestation; See Tree establishment
Fourwing saltbush
  R73-4 R73-171 R75-74
Fracture mapping
  R73-161
Friendship Park, Jefferson County, Ohio
  R69-9 R73-167 R74-74 R75-148
Fruit trees (See also Apple trees; Peach trees)
  R72-7 R74-12
Fulton County Health Department, Canton, Illinois
  R76-60
Fungal culture filtrates
  R68-16
Fur-bearing mammals
    Illinois, Vermilion County
        R42-3
Furrow grading
  R73-122 R73-124

Gannett Fleming Corddry and Carpenter, Inc., Engineers, Harrisburg, Pennsylvania
  R77-34
Gellman Research Associates, Inc., Washington, D.C.
  R76-10
General Electric Company
    Beltsville, Maryland
        R75-78 R76-3 R76-4
Geological Survey, U.S. Department of the Interior [See also Resource and Land Investigations (RALI) Program]
  R62-5 R63-11 R70-2 R72-23 R73-115 R74-76 R75-52
  R76-52
    Columbus, Ohio
        R77-29
    Water Resources Division, Lakewood, Colorado
        R76-55
Geology
  R73-183
    engineering
        R76-89
Georgia, surface mining
  R71-44
Germany (See also Cologne Lignite District)
    DOMSDORF ameliorative treatment
        R73-79
    mining and reclamation
        R64-19 R69-13 R72-40 R72-41 R72-65 R73-47
        R73-73 R73-100 R74-15 R74-95 R75-22 R75-83

Germany (continued)
reclamation
R74-113 R75-98 R75-127
Rhine Brown Coal Area
R73-62
Gilbreath, Foster and Brooks, Inc., Tuscaloosa, Alabama
R75-32
Glacial till, in Indiana spoil
R67-15
Glenharold Mine; See Consolidation Coal Company, Western Region
Glenrock Coal Company, Glenrock, Wyoming
Dave Johnston Mine
R76-55
Glossary of Surface Mining and Reclamation Technology
R74-37
Goddard Space Flight Center, Greenbelt, Maryland, NASA, U.S. Government
R75-78 R75-142 R76-3 R76-4
Golf courses (See also Recreation)
drainage from, contributing to acid mine water pollution
R74-53
Grafton Coal Company, Clarksburg, West Virginia
R72-42 R73-17 R74-22 R77-72
Grasses
R58-2 R69-19 R75-30
effects on tree establishment, Pennsylvania (See also Tree establishment, affected by ground cover)
R76-98
seed germination in acid spoil with fertilizer
R77-55
Grazing intensity, effects of
R77-36
Great Britain (See also Northumberland; Recreation, --; Yorkshire)
fertilizer requirement on coal mine spoils, South Lancashire
R74-115
reclamation
R57-4 R61-3 R71-11 R72-67 R74-24 R74-50
R74-113 R75-19 R75-110 R77-37 R77-75
farm land
R77-38
Rother Valley
R78-3
South Wales
R75-120
Greenwood Stripping Corp., Pennsylvania
R65-10
Ground stability
R75-9
Grove City College, Pennsylvania
R72-5 R75-10

GENERAL INDEX

Grundy County, Illinois, demonstration site
   R76-45
Gulf States Paper Corporation, Tuscaloosa, Alabama
   R75-32
Gwin, Dobson & Foreman, Mining Engineering Consultants, Altoona, Pennsylvania
   R75-44    R76-64

H & G Coal & Clay Co., Inc., Clarion, Pennsylvania
   R77-15
HRB-Singer, Inc., State College, Pennsylvania
   R77-45
Hallmark and Reid Coal Company, Trafford, Alabama
   R73-125
Hanaford Creek, Washington
   R73-84
Hanna Coal Company, Ohio; See Consolidation Coal Company
Hannover, Technical University of, Germany
   R73-47
Hardy Coal Co., Millersburg, Ohio
   R60-10
Harmon Creek Coal Company, Burgettstown, Pennsylvania
   R55-3    R66-6
Haulage roads; See Road design and construction
Haulback method of mining
   R72-42    R73-17    R74-21    R74-22    R75-27    R76-15    R76-59
   R77-72
Head-of-the-hollow fills
   R74-11    R77-10
      West Virginia, Kentucky, and Tennessee criteria compared
         R76-80
High Plains Grasslands Research Station, U.S. Department of Agriculture,
   Cheyenne, Wyoming
   R77-39
Highwall screening
   R71-29
Hillman State Park, Washington County, Pennsylvania
   R76-29
Hittman Associates, Inc., Columbia, Maryland
   R75-43
Hobet Mining & Construction Co., South Charleston, West Virginia
   R73-140    R76-59
Hoffman Coal Company, Karthaus, Pennsylvania
   R71-20
Holmes Limestone Company, Berlin, Ohio
   R77-52
Horizontal haul mining; See Multiple seam mining, costs
Horne Brothers Mining Company, Wise, Virginia
   R75-27

# GENERAL INDEX

House of Representatives, U.S. Congress
    Committee on Government Operations, Subcommittee on Conservation and Natural Resources
        R72-2
    Committee on Interior and Insular Affairs, Subcommittee on the Environment and Subcommittee on Mines and Mining
        R73-186
Housing development
    R75-27
Hybrid poplars
    R63-6    R63-20    R64-5    R71-20    R72-13    R73-116
Hydrologic data acquisition
    R73-152
Hydrology (See also AMAX Coal Company, Hydrology program; Streamflow)
    Arizona, Black Mesa
        R74-96    R75-63
    definitions of terms
        R75-18
    geology survey, Campbell County, Wyoming
        R76-52
    Indiana
        R73-1
    Kansas
        R72-43
    Kentucky
        R62-5    R63-11    R70-2    R73-43
    Montana
        R74-104    R76-94
    North Appalachian Experimental Watershed
        R77-29
    Ohio
        R72-64
    Pennsylvania, Mahanoy Creek
        R75-46
    spoil bank, mathematical model
        R77-16
    western United States
        R75-135    R76-66
        mathematical model
        R76-38

Ike Lake, Marion County, Iowa
    R51-4
Illinois Department of Mines and Minerals
    Division of Reclamation
        R75-102
Illinois Institute for Environmental Quality, Chicago
    R72-55    R73-25    R75-103    R76-45    R77-43    R78-2
Illinois legislation
    R60-12    R62-13    R64-41    R66-28    R74-128

# GENERAL INDEX

Illinois reclamation (See also Costs of reclamation, mathematical model, Illinois; Farming, Illinois; Metropolitan Sanitary District of Greater Chicago; Recreation; Southern Illinois University Cooperative Wildlife Research Laboratory; Will Scarlet Mine)
R28-1 R48-4 R49-2 R50-2 R51-1 R52-4 R58-2
R59-3 R62-10 R62-12 R63-16 R64-29 R65-33 R72-55
R73-25 R73-46 R74-19 R74-128
Illinois spoil characterization
R75-103
Illinois surface-mine ponds
R47-3 R52-4 R56-1 R59-1
Illinois surface-mined land
R56-5 R57-1 R57-9 R58-1 R59-5 R59-6
  pre-law
    R73-74
  Pyatt Striplands Research Area, Perry County, Illinois
    R58-4 R63-8
  survey
    R75-102
  taxes on
    R72-59
  wildlife, Vermilion County
    R42-3
Illinois, University of, Urbana
  Agricultural Experiment Station
    R51-1
  Department of Agronomy
    R77-42
Impact of mining, North Dakota
R73-182
Indian Head Mine; See North American Coal Corp.
Indiana Coal Producers Association, Terre Haute, Indiana
R40-1 R42-1 R47-1 R47-2 R49-4 R49-7 R49-9 R54-5
Indiana Geological Survey
R72-76
Indiana legislation
R43-1 R48-5 R51-3 R72-79
Indiana reclamation (See also Recreation --; Tree establishment --; Vegetation on spoil banks --)
R46-2 R47-2 R48-5 R48-6 R49-4 R49-9 R52-4
R54-5 R54-6 R55-1 R56-4 R62-1 R62-16 R65-30
R65-33 R66-26 R67-17 R69-22 R71-50 R72-76 R74-19
  Pike County
    R65-32
  problems
    R64-42
  Vigo County
    R58-5
Indiana spoil banks
R49-5

## GENERAL INDEX

Indiana spoil characterization
    glacial till
        R67-15
Indiana State Teachers College
  R61-12
Indiana State University
  R67-15
Indiana surface mining (See also Farming, farm land decrease, Indiana)
  R40-1 R48-2 R52-3 R65-23
    inventory of mined land
        R73-164
Indiana surface-mine ponds
  R51-3 R52-4 R71-36 R72-8 R73-20
Indiana University, Bloomington
  R48-5
    Water Resources Research Center
        R65-5 R65-6 R71-36
Industrial Environmental Research Laboratory, U.S. EPA
    Cincinnati, Ohio
        R76-29 R77-3 R77-34
Industrial parks
  R76-58
Information storage and retrieval systems
  R75-140
Interior Coal Province of the United States
    reclamation
        R78-5
Intermountain Forest and Range Experiment Station, U.S. Department of Agriculture
  R74-114 R74-122 R75-141 R76-36
International Harvester Company, Melrose Park, Illinois
  R73-174
Inventory of surface mines
    Quicksand Watershed, Breathitt County, Kentucky
        R75-139
Inventory of surface-mined areas
  R75-78
    Illinois
        R77-62
    Maryland
        R76-3 R76-4
Iowa Coal Research Association
  R55-6
Iowa reclamation
  R55-2 R77-31 R77-78
    and land values
        R75-80 R76-9
Iowa spoil characterization
  R55-6

# GENERAL INDEX

Iowa State College
  R51-4 R58-4
    Agricultural Experiment Station
      R55-6
Iowa State University, Ames
  R75-45
    Department of Agronomy
      R77-31
    Department of Economics
      R76-69
    Energy & Mineral Resources Research Institute, Coal Project
      R75-87 R76-37 R76-41 R76-42 R76-68 R77-2
      R77-6 R77-8 R77-14 R77-78 R77-83
Iron ore spoils
  R71-35
Irrigation
  R76-77
    sprinkler and drip compared
      R76-2
    with treated mine drainage
      R72-30

Johnson & Morgan Co., Snow Shoe, Pennsylvania
  R77-21
Jones & Brague, Tioga County, Pennsylvania
  R76-27

Kaiser Resources Ltd., Vancouver, British Columbia, Canada
  R71-5 R71-25 R75-36 R76-16
Kansas Agricultural Experiment Station, Manhatten
  R70-19
Kansas Geological Survey
  R71-27 R72-37 R72-43
Kansas reclamation (See also Black walnut trees,--; Tree establishment,--)
  R55-4 R61-8 R65-34 R71-3 R71-27 R72-37 R72-43
  R75-54
Kansas surface-mine ponds
  R65-8 R73-20
Kemmerer Coal Company, Frontier, Wyoming
  R66-9 R69-14 R69-19
Kent State University, Kent, Ohio
  R60-7 R63-14
Kentucky Agricultural Experiment Station, University of Kentucky, Lexington, Kentucky
  R77-3
Kentucky Department for Natural Resources and Environmental Protection
  R74-30 R74-93 R74-111 R75-71 R75-136 R75-138 R75-139
  R75-140 R75-145
    Division of Reclamation
      R72-68 R77-76

- Kentucky Department for Natural Resources and Environmental Protection (continued)
  - revegetation manual
    - R75-137
  - Strip Mining and Reclamation Commission
    - R65-12
  - Surface Mining Sediment and Water Quality Control Handbook
    - R74-36
- Kentucky Department of Fish and Wildlife Resources
  - R77-76
- Kentucky, land and socio-economic characteristics
  - R75-138
- Kentucky legislation
  - R65-18 R65-26 R73-11 R74-84
  - effects of
    - R70-1
  - regulations for head-of-hollow fills
    - R76-80
- Kentucky reclamation (See also Northeastern Forest Experiment Station; Vegetative guide)
  - R57-3 R59-2 R60-11 R61-4 R64-9 R65-3 R65-26
  - R65-31 R66-25 R72-30 R72-47 R73-11 R74-11 R74-19
  - R74-61 R75-3 R75-29 R75-66 R75-71 R75-125 R75-131
  - R77-10 R77-57 R77-67
  - and mining
    - R72-68 R74-111
  - eastern coal field
    - R66-24 R75-136 R75-145
  - western coal field
    - R77-3 R77-68
- Kentucky Reclamation Association
  - R57-3 R66-5 R75-69 R77-76
- Kentucky River, Kentucky
  - R74-93
- Kentucky spoil characterization
  - R65-7 R66-24 R68-15 R69-1 R69-23 R72-34
- Kentucky surface mining
  - R65-12 R65-18 R66-5 R67-3 R71-2 R71-8 R72-11
  - R73-11 R74-30 R74-68
  - Big Sandy Coal Reserve District
    - R67-6
  - effects on Tradewater River
    - R72-23
  - Hazard Coal Reserve District
    - R67-7
  - inventory of mined land
    - R73-164
  - Licking River Coal Reserve District
    - R67-5

Kentucky surface mining (continued)
    Princess Coal Reserve District
        R67-4
    Southwestern Coal Reserve District
        R67-8
    Upper Cumberland Coal Reserve District
        R66-12
    wildlife habitat on mined land
        R56-7 R77-76
Kentucky, University of, Lexington
    R72-34 R72-35 R74-39 R77-67
    Department of Agronomy (See also Kentucky Agricultural Experiment Station)
        R77-68
    Department of Civil Engineering
        R76-31
Kerr-McGee Coal Corp., Oklahoma City, Oklahoma
    Jacobs Ranch Mine, Gillette, Wyoming
        R77-40
L. Robert Kimball, Consulting Engineers, Ebensburg, Pennsylvania
    R74-93
    Lexington, Kentucky
        R75-145
Knife River Coal Mining Co., Bismarck, North Dakota
    R65-9 R66-8 R67-2
    Beulah Mine, North Dakota
        R77-44
    costs of reclamation
        R73-177
    Savage Mine, Savage, Montana
        R75-109
Kucera and Associates, Inc., Mentor, Ohio
    R73-3

Lakes; See surface-mine ponds under names of states
Land Management, Bureau of, U.S. Department of the Interior; See Denver Service Center
Land use (See also Airport expansion; Black Mesa, Arizona --; Disposal of solid wastes; Farming; Housing development; Industrial parks; Management of reclaimed land; Recreation; Schools)
    R61-9 R64-4 R64-31 R64-35 R66-17
    impacts of surface mining in eastern Kentucky
        R75-139
    of mined land, Indiana
        R59-7 R61-12 R71-49
    of reclaimed land
        R62-15 R74-3
        Illinois
        R71-52

Land use (continued)
    planning
        R73-92    R74-17    R77-48
    statistics on land mined and reclaimed
        R73-121    R74-65    R74-103
    U.S. Government policy (See also Federal coal leasing)
        R72-39    R73-56    R73-68
    West Virginia
        R76-43
Land value, effects of surface mining and reclamation methods on
    R47-4    R75-80    R76-9
Landscape architecture (See also Aesthetics of reclaimed land)
    R73-37    R73-57    R75-121
Langley Research Center, U.S. NASA
    R74-84
Latex as soil stabilizer
    R74-55
Laurel Highlands Conservation and Development Project, Pennsylvania
    R76-25
Laurel Hill Creek, Pennsylvania
    R76-25
Laurel Run, West Virginia
    R75-33
Leaf litter decomposition
    R77-49
Leatherwood Creek, Kentucky
    R71-2    R73-43
Legal problems of reclamation
    R72-21
Legislation and regulations (See also Economic effects of; Federal legislation; State legislation; See also under names of states)
    R76-96
    affecting land use planning
        R77-48
    economic impacts of
        R76-83
    PL 95-87, "Surface Mining Control and Reclamation Act of 1977"
        R77-33
    review
        R69-26    R73-177    R76-37    R77-71
    suggested
        R73-173
Legumes
    R58-2
Lepoco Coal Company, Pennsylvania
    R66-2
Library Services, Office of, U.S. Department of the Interior
    R71-15

# GENERAL INDEX

Lichen
  accumulation of metals from acid spoil
    R75-113
  mechanism for accumulation of metals
    R77-51
Lime, effects on bermudagrass growth
  R77-54
Little Mill Creek, Ohio
  R72-64 R73-155
Liverpool, University of, Great Britain
  Department of Botany
    R74-115
Live stock (See also Farming, beef cattle; Grazing intensity; Meadowlark Farms, Inc.)
  R55-4
Loblolly pine
  R73-12 R73-13 R73-168
Lonesome Pine Soil Conservation District, Clintwood, Virginia
  R64-1 R64-40 R76-8
Longwall surface mining
  R73-83 R73-94 R74-94 R74-124
  feasibility study
    R73-144 R74-66
Los Lunas Plant Materials Center, University of New Mexico
  R74-60
Louisville, University of, Kentucky
  R75-114
Lovegrass; See Palar lovegrass; Weeping lovegrass

Machinery for mining and reclamation (See also Backhoes; Big blade; Big Muskie; Bucketwheel excavators; Excavators; Rangeland drill; Scrapers; Vertical shaft excavation and spoil placement)
  R64-14 R69-8 R71-3 R71-31 R72-61 R73-69 R73-125
  R73-134 R73-141 R73-179 R73-189 R74-23 R74-44 R74-77
  R74-106 R75-28 R75-64 R75-87 R75-96 R75-107 R75-122
  R75-124 R76-46 R76-65 R76-82 R77-21 R77-22 R77-63
  R77-64
  costs of earth handling
    R73-174
  equipment selection for large operations, mathematical model
    R77-60
Magnesium sulfate, effect on perennial forage species
  R76-78
Mahanoy Creek, Pennsylvania
  R75-46
Maid Marian Farms, Indiana
  R56-4
Management of reclaimed land
  R76-96
Managanese toxicity
  R68-15 R74-116

# GENERAL INDEX

Manual for establishment of vegetation on mined land, Kentucky
   R75-137
George C. Marshall Space Flight Center, Huntsville, Alabama, NASA, U.S. Government
   R75-106
Maryland Department of Health and Mental Hygiene
      Division of Solid Waste Control
         R73-187
Maryland Geological Survey
   R76-3     R76-4
Maryland, surface-mine inventory
   R76-3     R76-4
Maryland, University of, Law School
   R72-21
Massachusetts, University of, Amherst, Massachusetts
      ARSTECNICA and Institute for Man and Environment
         R76-19     R76-57     R77-13     R77-56
Massengale Mountain, Campbell County, Tennessee
   R74-2     R77-18
Mathematica, Inc., Princeton, New Jersey
   R74-30     R74-111     R75-14     R76-24     R77-72
Mathematical model (See also Agricultural water needs, models; Costs of mining, --; Costs of reclamation, --; Hydrology, spoil bank, --)
      costs of mining and reclamation
         R76-68
      costs of reclamation
         R74-117
      equipment selection for large mining and reclamation operations
         R77-60
      impacts of mining on streamflow
         R75-149
      parting handling
         R77-25
      plans for small surface mines
         R77-14
      streamflow
         R72-64
      surface mining systems
         R75-8     R75-45
      water availability and use, western United States
         R76-38
      water quality
         R75-49
Mayes, Sudderth and Etheredge, Inc., Lexington, Kentucky
   R75-139
John McCormick and Associates, Devon, Pennsylvania
   R75-46
Meadowlark Farms, Inc., AMAX Coal Company
   R52-2     R71-7     R73-38     R73-120     R74-75     R74-81     R74-82
   R74-83     R77-74

GENERAL INDEX

Meridian Engineering, Inc., Philadelphia, Pennsylvania
   R75-130
The Metropolitan Sanitary District of Greater Chicago (See also Chicago Prairie Plan; Palzo site; Sewage as fertilizer)
   R73-82 R73-88 R73-104 R73-149 R74-70 R74-121 R75-37
Mice on surface-mined land
      Illinois
            R57-9
Michigan State University, East Lansing
   R61-5
Michigan, University of, Department of Conservation, Ann Arbor
   R61-1
Microorganisms
      in soil (See also Leaf litter decomposition)
            R77-17 R77-50
            effect of storage of soil on
            R76-63
            Montana
            R77-32
      in spoil (See also Rhizobium)
            R56-3 R73-95
Midland Coal Company, Trivoli, Illinois
   R75-12 R75-86
Mid-West Coal Producers Institute, Inc., Terre Haute, Indiana
   R62-10 R67-17 R71-50
Mid-west reclamation (See also names of mid-western states; Western Interior Coal Province)
   R75-22
Midwest Research Institute, Kansas City, Missouri
   R76-60
Mined Land Conservation Conference, National Coal Association, Washington, D.C.
   R64-33 R64-38 R64-41 R65-27 R65-35 R66-13 R72-51
Mines, Bureau of, U.S. Department of the Interior
   R66-7 R68-8 R69-21 R70-10 R71-34 R71-48 R72-10
   R74-19 R74-65 R74-117 R75-14 R75-22 R75-124 R76-40
   R76-76 R76-82 R77-25 R77-66
      Division of Environment Field Office, Wilkes-Barre, Pennsylvania
            R76-5
      Eastern Field Operation Center - Field and Environmental Activities
            R75-95
      Office of Assistant Director, Mining
            R76-15 R76-24 R76-28 R76-88
Mining and Metallurgy, University of, Krakow, Poland
   R75-144
Mining forecast
   R65-29

## GENERAL INDEX

Mining methods
   (See also Advance surface mining; Auger mining; Backfilling; Bench method; Block-cut method; Box-cut method; Controlled placement; Cross-ridge mining; Haulback method; Head-of-the-hollow method; Longwall surface mining; Machinery for mining and reclamation; Multiple-seam mining; Periphery mining; Slope-reduction method; Steep-slope mining; Terrace-pit mining; Throw-it-over-your-shoulder; Tower excavator mining)
   R55-3 R60-10 R69-20 R71-40 R72-22 R72-38 R72-51
   R74-5 R74-41 R75-62
      feasibility study
         R76-15
      overburden handling
         R76-24
Minnesota, University of
      Forestry Library, bibliography
         R76-1
Missouri reclamation
   R54-1 R74-19
      Project Reuse
         R75-76
Missouri River Basin
   R75-53
Missouri surface-mine ponds
   R64-26 R74-54
Missouri, University of
      Agricultural Experiment Station
         R51-2
      Division of Biological Sciences
         R77-7
      Rolla, Missouri
         R75-67
Models, modeling; See Mathematical models
Monitoring reclamation; See Remote sensing techniques
Monongahela Power Company, West Virginia
   R72-3
Monongahela River Basin, pollution control costs in
   R73-7
Montana Bureau of Mines and Geology
   R74-104 R76-94
Montana College of Mineral Science & Technology
   R77-25
Montana Department of Fish and Game
   R75-93 R75-117
Montana legislation
   R69-11 R70-7
Montana mining
      hydrology
         R76-94
Montana reclamation (See also Peabody Coal Company; Vegetation on spoil banks)

Montana reclamation (continued)
  R72-25 R73-39 R73-40 R73-66 R73-115 R74-99 R75-89
  R75-93 R75-105 R75-108 R75-119 R75-141
    at Colstrip
      R73-136
      soil development
        R77-77
Montana spoil characterization
  R75-132
    Decker Mine, Montana, hydrologic and soil properties
      R76-36
Montana State University, Bozeman, Montana
  R75-119 R77-32
    Agricultural Experiment Station
      R72-25 R72-26 R77-77
      research review
        R78-4
    Animal and Range Sciences Department
      R73-136
Montana surface-mined lands
  R77-32
Moraine State Park, Butler County, Pennsylvania
  R70-10 R73-57
Morava River, Yugoslavia
  R73-52
Mountain rye
  R73-171
Mountaineer Coal Company, West Virginia; See Consolidation Coal Company
Mountaintop removal (See also Cross-ridge mining; Head-of-the-hollow fills)
  R74-10 R74-26 R75-27 R75-96 R76-92 R77-61
    in multiple-seam mining
      R77-79
Mulches
  R72-46 R73-106 R75-66
Multiple-seam mining
  R73-6
    contour backfilling
      R74-2
    costs
      R75-13
    with mountaintop removal
      R77-79
Municipal compost
  R73-132
Muskrats
  R59-1
Mycorrhizae
  R75-74 R75-115 R77-53
    effects on tree establishment
      R76-62

Myles Job Mine
   R68-2   R68-3

NUS Corporation; See Cyrus Wm. Rice Division, Pittsburgh, Pennsylvania
National Academy of Sciences
      Study Committee on the Potential for Rehabilitating Lands Surface Mined for Coal in the Western United States
         R74-126
National Aeronautics and Space Administration, U.S. Government; See Goddard Space Flight Center; Langley Research Center; George C. Marshall Space Flight Center
National Coal Association, Washington, D.C. (See also Mined Land Conservation Conference)
   R71-18   R73-8   R73-33   R74-4   R74-37
National Endowment for the Arts, U.S. Government
   R76-19
National Environmental Research Center, Cincinnati, Ohio, U.S. EPA
   R72-22   R74-41
Natural plant succession
      western United States coal fields
         R77-23
Natural restoration of surface-mined land
   R74-85
New Mexico reclamation (See also Los Lunas Plant Materials Center; Soil characteristics; Utah International, Navajo Mine; Vegetation on spoil banks)
   R73-171   R74-6   R74-102   R75-75   R75-99   R76-67   R76-84
   R77-1
New Mexico spoil characterization
   R75-41   R77-53
New Mexico State University
      Agricultural Experiment Station
         R75-134   R77-59
      Department of Agronomy
         R75-41
New plant material
   R73-127
New River Watershed, Tennessee
   R75-149   R77-16
Nitrogen
      availability in acid spoil
         R68-4
      requirement on mined land
         R74-115
Noise control
   R75-15   R75-31
Norfolk and Western Railway Company, Roanoke, Virginia
   R73-117

## GENERAL INDEX

The North American Coal Corporation, Western Division, Bismarck, North Dakota
      Indian Head Mine, Beulah, North Dakota
            R74-33    R75-92    R75-109    R76-63
North Appalachian Experimental Watershed, U.S. Department of Agriculture,
   Agricultural Research Service, Coshocton, Ohio
   R77-29
North Branch Potomac River
   R74-84
North Central Forest Experiment Station, U.S. Department of Agriculture
   R74-121
North Dakota Geological Survey
   R64-3    R75-121
North Dakota legislation
   R69-11    R70-7    R73-172
North Dakota reclamation
   R65-9    R66-8    R67-2    R73-188    R75-121    R75-154    R76-21
   R76-70    R77-36    R77-44
      history
            R73-176
North Dakota spoil banks
   R64-3
North Dakota spoil characterization
   R75-132    R76-85    R77-17
North Dakota surface mining
      impacts of
            R73-182
      socio-economic effects of
            R73-178
North Dakota, University of, Grand Forks
   R75-121
Northeastern Forest Experiment Station, U.S. Department of Agriculture
   R63-5    R63-20    R64-5    R66-3    R66-12    R67-3    R67-4
   R67-5    R67-6    R67-7    R67-8    R68-12    R68-15    R69-2
   R69-23    R69-24    R70-4    R70-5    R71-46    R72-12    R72-13
   R72-17    R72-52    R73-111    R74-31    R74-123    R75-47    R75-49
   R75-66    R75-69    R75-77    R75-131    R76-26    R76-72    R78-12
   R78-13
      Berea, Kentucky
            R75-136    R76-31    R77-19
            revegetation manual
            R75-137
            Surface-Mined Area Restoration Research Project
            R71-38    R74-16
      Kingston, Pennsylvania
            R73-175    R77-20
      Princeton, West Virginia
            R73-184
      program review
            R78-8

# GENERAL INDEX

Northern Great Plains reclamation (See also names of Northern Great Plains States; Vegetation on reclaimed lands, --)
R73-129 R73-185 R74-33 R74-114 R75-17 R75-92 R77-4
R78-9
  mine inventory
    R76-91
  wooded waterways
    R77-65
Northern Great Plains Research Center, U.S. Department of Agriculture, Mandan, North Dakota
R75-91 R75-132 R76-73 R76-77 R76-78 R77-26 R77-36
R78-9
Northern Great Plains Resources Program
R73-32 R74-67 R74-122 R75-53
Northumberland County reclamation
R70-14
Nut trees (See also Black walnut trees)
R71-21
Oak Ridge National Laboratory, Oak Ridge, Tennessee
  Energy Division
    R76-83
  National Science Foundation Environmental Program
    R72-41 R75-44 R76-64
  Systems Studies of Coal Production Programs
    R75-146
Office; See other part of title
Ohio Agricultural Experiment Station
R53-2 R60-9 R61-10 R62-8 R64-13 R65-20
Ohio Agricultural Research and Development Center, Wooster, Ohio
R65-21 R66-15 R70-16 R73-148 R73-155 R77-28 R77-29
R77-82
Ohio Department of Natural Resources
  Board on Unreclaimed Strip Mined Lands
    R74-56
  Division of Wildlife
    R54-4
  Mined Lands Restoration Unit
    R74-112
Ohio Edison Company, Akron, Ohio
R70-17
Ohio legislation
R64-7 R72-27
Ohio Mining and Reclamation Association
R64-39 R64-44 R70-20 R75-126
Ohio Power Company, Canton, Ohio
R64-21 R67-10 R68-10 R69-16
Ohio reclamation (See also Conotton Creek, --; Peach trees, Ohio; Recreation; Tree establishment; Vegetation on spoil banks, Ohio)
R41-2 R49-3 R52-4 R53-2 R54-3 R61-4 R64-18 R64-23
R64-24 R65-17 R65-31 R65-33 R66-14 R68-11 R70-21 R70-22
R73-170 R74-19 R74-56 R74-108 R75-142 R77-52

Ohio spoil characterization
    R47-4 R61-5 R61-10 R64-2
        Belmont and Noble Counties
            R72-78
The Ohio State University, Columbus, Ohio
    R47-4 R52-4 R72-77 R73-30
        Department of Agronomy
            R77-28
        Department of Botany
            R77-49 R77-50 R77-51
        Water Resources Center
            R72-64 R73-155
Ohio surface mining
    R64-15 R64-16 R64-17 R69-4 R73-3
Ohio surface-mine ponds
    R52-4 R60-5 R60-7 R68-10
Ohio surface-mined land
        Perry County
            R75-113 R77-49 R77-50
        Tuscarawas County
            R47-4
Ohio University, Athens
    R73-3 R73-170
Oil shale, vegetation on
    R74-87
Oklahoma reclamation
    R53-1 R54-1
Oklahoma surface mining
    R41-1
Old West Regional Commission, U.S. Government
        bibliography
            R74-118
Outdoor Recreation, Bureau of, U.S. Department of the Interior
    R74-74
        aid in reclaiming mined land
            R74-91
Overburden (See also Spoil)
        analysis
            R76-71
        estimating amount of
            R76-18
        handling (See also Mining methods; Parting handling)
            in mining Stearns #2 coal, Kentucky
            R75-29
Ozarks Regional Commission, U.S. Government
    R71-3 R71-27 R72-37

P & K Inc., Port Allegany, Pennsylvania
    R54-2

# GENERAL INDEX

Palar lovegrass
  R73-77
Palzo Project, Williamson County, Illinois
  R72-71 R75-114 R76-47
Park Aerial Surveys, Inc., Louisville, Kentucky
  R75-26
Parting handling
  R77-25
Pastures on mined land
  R64-21
Patoka River, Indiana
  R65-5 R65-6
Peabody Coal Company, St. Louis, Missouri
  R65-4 R66-4 R67-16 R69-10 R71-32 R72-44 R73-28
  R73-64 R73-91 R73-105 R74-38 R75-15 R77-67
    Big Sky Mine, Colstrip, Montana
      R73-115 R74-51 R74-76 R75-132 R75-143
    Black Mesa, Arizona
      R70-11 R74-96 R75-63 R75-150 R75-151 R77-81
    Central City, Kentucky
      R77-68 R77-76
    disposal of sewage on mined land
      R76-44
    Seneca 1 and 2 Mines
      R75-42
    Universal Mine
      R71-19 R73-103
Peach trees
    Ohio
      R57-6
Pennsylvania Coal Mining Association
  R67-11 R68-13
Pennsylvania Coal Research Board
  R65-1
Pennsylvania Conservation Association
  R63-13 R65-16
Pennsylvania Department of Environmental Resources
  R75-46
    Bureau of Surface Mine Reclamation
      R76-98
Pennsylvania Department of Health
  R65-1
Pennsylvania legislation (See also Pennsylvania Surface Mining, regulation)
  R49-6 R65-13 R71-41 R72-48
Pennsylvania reclamation (See also Tioga County, Pennsylvania, Demonstration Project; Tree establishment; Vegetation on spoil banks)
  R54-2 R56-2 R62-9 R63-7 R64-12 R65-1 R66-7
  R66-10 R67-11 R72-33 R75-6 R75-10 R77-15 R77-20
    and mining (See also Hillman State Park; Anthracite surface mining)
      R49-6 R76-27 R77-21

## GENERAL INDEX

- Pennsylvania Science and Engineering Foundation
  R76-54
- Pennsylvania spoil banks
  R60-4
- The Pennsylvania State Forest School
  R48-1 R58-3 R62-6 R63-3
- The Pennsylvania State University
  - College of Earth and Mineral Sciences
    R73-141
  - Department of Forestry and Wildlife
    R71-12
  - Department of Geography
    R76-54
  - Department of Landscape Architecture
    R68-9
  - Institute for Research on Land and Water Resources
    R74-90 R75-94
  - Office of Remote Sensing of Earth Resources
    R73-5
  - School of Forest Resources
    R70-15 R71-37 R73-86 R77-46
- Pennsylvania surface mining (See also Anthracite surface mining)
  - Allegheny County
    R67-13
  - regulation
    R76-25
- Pennsylvania surface-mine ponds
  R72-5
- Performance bonds
  R74-39
- Periphery mining
  R76-15
- Permits, requirements for
  R74-51 R75-65
  - West Virginia
    R75-50
- Perry and Hylton, Inc., West Virginia
  R74-69
- Perry Brothers Coal Company, Pennsylvania
  R75-6
- Personnel for environmental studies
  R75-56
- Phosphate mining, Idaho
  R73-102
- Phosphorus in spoil
  R69-23
  - requirement on mined land
    R74-115
- Photogrammetric Services, Inc., Reynoldsburg, Ohio
  R76-18

## GENERAL INDEX

Pines, direct seeded on Kentucky spoil
  R74-123
Pioneer Fuel Company, West Virginia
  R74-107
Pioneer vegetation
  R60-4
Pittsburg & Midway Coal Mining Company, Denver, Colorado
  R55-4 R65-4 R73-21 R73-31 R73-69 R73-70 R73-71
  R75-28 R75-107 R75-122 R75-124 R76-67 R77-63
    Madisonville, Kentucky
      R77-76
    McKinley Mine, Gallup, New Mexico
      R77-1
Pittsburgh, University of, Pittsburgh, Pennsylvania
    Graduate Center for Public Works Administration
      R72-60
    Pymatuning Laboratory of Ecology
      R73-2
Pittston Company, Greenwich, Connecticut
    Buffalo Mining Company, Lorado, West Virginia
      R77-11
    Coal Group
      R72-50
Planning for reclamation; See Reclamation planning
Plant ecology
  R75-88
Plant Stress Laboratory, Plant Physiology Institute, ARS-USDA
  R74-116
Planting methods
  R76-96
Poland (See also Mining and Metallurgy, University of; Spoil amendments, --)
    lignite mining
      R75-157
    openpit mining and environmental problems
      R75-111
    spoil toxicity
      R74-109 R75-144
    surface-mined land and reclamation
      R73-95 R74-49 R76-12 R77-5
        Turow Lignite Mine
      R73-119 R75-81
    vegetation studies on amended spoils
      R74-109 R75-81 R76-11
Ponderosa pine
  R77-20
Ponds; See Fish in surface-mine ponds; See surface-mine ponds under names of states
Population trends in mined areas, Indiana
  R61-12

Potassium requirement on mined land
  R74-115
Potomac Engineering & Surveying, Petersburg, West Virginia
  R74-66
Potomac River; See North Branch Potomac River
Powder River Basin, Wyoming, Montana
  R75-23   R75-156
    planning for mineral resource development
      R74-17
    water quality
      R75-133
Precipitation effects on pond water levels (See also Flooding)
  R60-5
Princess Susan Coal Company, Charleston, West Virginia
  R74-21
Production reports; See Computer generation of monthly production reports
Pulpwood production
    in Pennsylvania
      R64-8   R64-27
    in the South
      R67-9
Purdue University, Lafayette, Indiana
  R49-4   R49-5   R50-3   R54-6   R55-1   R73-22   R73-96
Pyrite
    effect of grain size on quality of drainage
      R73-26
    oxidation
      R75-67

RECLAM, USDA Program for Reclamation of Lands Affected by Mining
  R76-48
Rainfall simulation
  R76-55
Raleigh Empire Coal Company, West Virginia
  R76-35
Rangeland drill
  R75-69
Reclamation associations (See also names of associations)
  R50-1
Reclamation costs; See Costs of reclamation
Reclamation forecast
  R65-11   R69-17   R69-18
Reclamation history (See also pre-1960 publications)
  R64-14   R65-35   R66-27   R67-17   R69-18
    North Dakota
      R73-176
Reclamation methods (See also Valley-fill method)
    evaluation
      R76-24

# GENERAL INDEX

Reclamation planning (See also Spoil analysis)
  R64-10 R64-20 R65-35 R72-20 R72-54 R73-123 R73-150
  R73-165 R73-166 R74-19 R74-41 R74-79 R74-88 R76-14
  R76-28 R76-96 R76-97 R77-6
    aesthetics
      R76-19
    computer graphics
      R77-56
    western coal fields
      R76-75
Reclamation programs, states
  R76-50 R76-51
Reclamation research (See also Natural restoration of surface-mined land)
  R49-1 R66-16 R67-12
    cooperative program of U.S. Department of Agriculture and Virginia Polytechnic Institute and State University
      R72-69
    needs
      R71-47 R74-92
    not used in developing legal regulations
      R76-79
Reclamation review (See also United States, mining and --)
  R57-7 R60-8 R62-2 R63-4 R63-18 R64-22 R64-30
  R64-41 R65-22 R65-24 R66-27 R69-15 R69-26 R70-6
  R70-23 R72-56 R72-73 R72-75 R73-29 R73-33 R73-80
  R73-135 R73-142 R73-177 R74-15 R74-20 R74-29 R74-72
  R75-16 R75-104 R75-130 R76-30 R76-76
    Illinois
      R71-52
Reclamation technology training
  R76-6
Recreation (See also Camp sites; Conference on Reclamation of Surface-Mined Lands for Outdoor Recreation; Fish and fishing; Friendship Park, Ohio; Lakes from final cuts; Moraine State Park, Pennsylvania)
  R55-3 R61-6 R62-10 R63-8 R64-29 R72-43 R73-180
  R75-39 R75-40
    Great Britain
      R78-3
    Illinois
      R66-18 R70-18
    Indiana
      R64-37 R65-32 R71-49
    Ohio
      R69-16
    Pennsylvania, Lackawanna County
      R76-5
Red pine
  R73-2
Refuse from coal cleaning (See also Vegetation on refuse banks)

Refuse from coal cleaning (continued)
    characteristics, Will Scarlet Mine, Illinois
        R72-74
    disposal costs, Alabama and Kentucky
        R69-21
Remote sensing techniques (See also Aerial photography)
    R71-34  R72-49  R73-3  R73-5  R73-30  R73-51  R73-152
    R73-161  R73-170  R74-84  R74-108  R76-91
    ERTS-1 imagery
        R75-142
    LANDSAT imagery
        R75-78  R76-3  R76-4
    MOSAIC/Photomontage
        R76-33
Research and Development, Office of, U.S. EPA
    R74-66  R74-88
Research and Monitoring, Office of, U.S. EPA
    R72-30
Resource and Land Investigations (RALI) Program, U.S. Geological Survey
    R76-49  R76-50  R76-51  R77-48
Resources for the Future, Inc.
    R66-1
Revegetation; See Vegetation
*Rhizobium* used to enhance nitrogen fixation of *Robina pseudoacacia L.*
    R73-126
Cyrus Wm. Rice Division, NUS Corporation, Pittsburgh, Pennsylvania
    R72-30
Road design and construction
    R68-14  R76-88  R77-58
    drainage
        R65-28
Rock layers between coal seams; See Partings
Rocky Mountain Forest and Range Experiment Station, U.S. Department of Agriculture
    R73-4  R73-171  R75-70  R75-74  R75-128  R75-156  R76-2
    R76-84  R77-1  R77-53  R77-65
    research program review
        R75-75  R78-1
Rodent population survey, Colstrip, Montana
    R73-136
Row crops; See Farming
Runoff (See also Erosion control)
    R72-11
    from agriculture
        R76-53
    from spoil
        R49-9  R65-5  R65-6
        rainfall simulation studies
            North Dakota
                R77-26

Runoff (continued)
            Wyoming
                R76-55
        treated with sewage sludge
        R74-121
            Palzo site
                R72-71
Rural Mining Company, Hurley, Virginia
    R75-123
Russia, mining
    R69-13

SUNEDCO Coal Company, Dallas, Texas
    Cordero Mine, Gillette, Wyoming
        R77-80
St. Meinrad College, Indiana
    R72-8
Sand and gravel mining and reclamation
    R62-15
Sandstone weathering
    R74-47
Saskatchewan, Canada
    vegetation on spoil banks
        R74-119
Saskatchewan, University of, Saskatoon, Saskachewan, Canada
    R74-119
Schools on reclaimed land
    R76-92
Science and Education Administration, U.S. Department of Agriculture
    R78-11
Scrapers
    R75-7
Sediment ponds (See also Erosion and sedimentation; Turbidity reduction)
    R73-49    R75-43
    Drainage Handbook, West Virginia
        R75-20
    Engineers' Handbook, Kentucky
        R74-36
    West Virginia
        R74-107
Seed ledges
    R73-76
Seeding
    R73-42    R73-134    R74-61    R74-62
    of pine
        R73-169    R75-48
    of trees and shrubs
        R76-72
    timing
        R73-13

## GENERAL INDEX

- Seeds
  - collected from native western plants
    - R75-143
  - in topsoil
    - R75-82
- Seminoe Mine No. 1, Hanna, Wyoming; See Arch Mineral Corporation
- Senate, U.S. Congress
  - Committee on Interior and Insular Affairs
    - R72-39 R73-35
- Sewage as fertilizer (See also Chicago Prairie Plan; Municipal compost; Palzo site)
  - R70-15 R71-12 R71-37 R72-24 R72-31 R72-32 R72-45 R72-62 R73-86 R73-148 R74-90 R74-121 R75-94 R76-44 R77-34
  - sludge disposal on mined land
    - Illinois, odors from
      - R76-60
    - Ohio
      - R76-10
- Shawnee National Forest, U.S. Department of Agriculture, Harrisburg, Illinois
  - R72-71
- Shear strength of mine spoils
  - R78-13
- Sheban Mine, Mahoning County, Ohio
  - R74-1
- Sherwood-Templeton Coal Co., Indianapolis, Indiana
  - R56-4
- Sierra Club
  - R75-17
- Site preparation
  - R73-18
- Skelly and Loy, Engineers, Consultants, Harrisburg, Pennsylvania
  - R73-114 R75-22 R75-24 R76-17 R76-76 R76-88 R77-10 R77-13 R77-58 R77-72
- Slippery Rock State College, Slippery Rock, Pennsylvania
  - R76-62
- Slope reduction method
  - R70-8
- Slope stability (See also Shear strength of mine spoils; Spoil bank stability)
  - R76-89
- Socio-economic effects of western coal mining
  - R74-67
  - North Dakota
    - R73-178
- Sodic spoils
  - chemical reclamation, leaching with soluble Ca salts
    - R75-91

Sodium sulfate, effect on perennial forage species
  R76-78
Soil; See also Topsoil
Soil analysis methods
  R78-11
Soil characteristics
  R76-31
    Alabama mined land
      R76-56
    mapped
      R76-70
    New Mexico, San Juan County
      R75-134
    wettability, Fruitland formation, New Mexico
      R77-59
Soil Conservation Service, U.S. Department of Agriculture
  R64-1 R64-32 R64-36 R65-2 R66-11 R69-25 R70-23
  R72-78 R74-20 R74-101 R75-38 R75-54 R77-12 R77-24
    Morgantown, West Virginia
      R76-43
    plant performance review
      R78-10
    Program RECLAM
      R76-48
Soil development (See also Earthworms; Leaf litter decomposition; Microorganisms in soil)
  R71-35 R75-12 R75-30 R75-88
    Montana, Colstrip area
      R77-77
Soil mechanics
  R76-31
Soil reconstruction
  R76-61
Soil stabilizers (See also Latex)
  R72-46 R73-106
Solid waste disposal
    in surface-mine pits
      R60-3 R71-42 R72-4
    with mined-land reclamation
      R76-32
Solid Waste Management Programs, Office of, U.S. Environmental Protection Agency
  R73-187
South Dakota School of Mines and Technology, Rapid City, South Dakota
  R75-133
Southeast Kansas Outdoor Recreation Association
  R65-34
Southeastern Forest Experiment Station, U.S. Department of Agriculture, Athens, Georgia
  R75-115

Southern Illinois University, Carbondale, Illinois
    Coal Research Center
        R77-78
    Cooperative Wildlife Research Laboratory
        R56-8 R59-1 R62-10 R72-28 R72-74 R75-102
        R75-103 R77-62
    Department of Botany
        R78-2
Southwestern Illinois Coal Corporation, Indianapolis, Indiana
    R66-18 R69-13
Special Foreign Currency Program, U.S. EPA
    R74-109 R76-11
Spoil acidity (See also Acid spoil; Lime)
    decreased by blending acid and neutralizing strata
        R75-58
    Kentucky
        R67-3 R69-23
Spoil amendments (See also Fly ash; Fungal culture filtrates)
    Poland, to treat toxic spoils
        R75-144
Spoil analysis [See also AMAX Coal Company, SOAP (Soil Overburden Analysis Program)]
    R74-8 R74-31 R74-89 R75-85
    Illinois, Will Scarlet Mine
        R72-74
    New Mexico
        R75-99
Spoil bank outslopes, calculating the area of
    R63-10
Spoil bank stability
    R68-7
    bibliography
        R64-13
    Kentucky
        R66-21 R73-163
    manual for landslide prevention
        R75-145
Spoil characterization (See also under names of states)
    R49-5 R55-2 R60-7 R64-32 R71-16 R73-22 R73-61
    R73-81 R74-42
    Northern Great Plains
        R76-78
Spoil chemistry
    R75-101
Spoil classification
    R48-3 R69-25 R72-78 R73-158 R74-88
    Ohio
        R44-2 R77-28
    Pennsylvania
        R73-90

Spoil compaction
  R58-5
    effect on tree growth
      R67-14
Spoil fertility
  R73-45
    availability of phosphorus
      R69-23
      and potassium
      R73-14
Spoil, graded, moisture and density of
  R73-44
Spoil leachates
  R75-133
Spoil pH, determination of
  R69-2
Spoil properties that influence minesoils
  R76-87
Spoil texture, aggregation
  R57-5
    effect on vegetation
      R71-46
Spoil toxicity
    manganese
      R68-15
    Poland
      R74-109
    to treat toxic spoils
      R75-144
    zinc, copper, and nickel in eastern Kentucky spoil
      R72-34    R72-35
Spoil weathering (See also Sandstone weathering)
  R61-5    R62-8    R64-34    R65-21
    affected by furrow grading
      R73-122    R73-124
Spoil wettability; See Water infiltration, wettability of spoils
Sport Fisheries and Wildlife, Bureau of, U.S. Department of the Interior
  R68-1
Stability; See Ground stability; Spoil bank stability
Stahlman Coal Company, Inc., Corsica, Pennsylvania
  R56-2
Stanford Research Institute, Menlo Park, California
  R72-57
State legislation
  R60-12    R64-6    R64-30    R72-56    R74-78
Steeply pitching seams
  R72-63
Steep-slope mining and reclamation
  R74-46    R74-57    R74-94
    back-to-contour demonstration
      R77-18

Steep-slope mining and reclamation (continued)
    Tennessee
        R73-6 R74-13
    West Virginia
        R73-140 R74-45
Streamflow affected by surface mining, mathematical model
    R75-149
Stripmine; See Surface mine
Sunnyhill Coal Company, New Lexington, Ohio
    R54-3
Surface manipulation for moisture retention
    R75-109 R77-35
Surface Mining Research Library, Charleston, West Virginia
    R74-35
Surface mining review
    R63-1 R63-19 R74-95
Survey of public attitudes; See Attitude Survey
Susquehanna River, Pennsylvania; See West Branch Susquehanna River
Systems analysis in reclamation
    R75-152

Tall fescue
    R74-116
Taxes
    on coal produced
        R74-39
    on surface-mined land
        R72-59 R73-25
Technical College of Aachen, West Germany
    R73-10
Tennessee Department of Conservation
    R75-72
Tennessee reclamation
    R75-72 R77-9
Tennessee regulations
    head-of-hollow fills
        R76-80
Tennessee surface mining
    R60-2 R66-22
Tennessee, University of, Knoxville
    Appalachian Resources Project
        R73-186 R74-13
    Department of Civil Engineering
        R75-149 R77-16
    Department of Economics
        R76-83
    Water Resources Research Center
        R73-153
Tennessee Valley Authority, U.S. Government
    R63-1 R73-12 R73-13 R75-71 R75-72 R75-73 R77-69

Tennessee Valley Authority, U.S. Government (continued)
    Division of Forestry, Fisheries, and Wildlife Development
        R77-18    R77-55
    National Fertilizer Development Center
        R74-59
    Office of Engineering Design and Construction
        R71-39
Terrace pit mining
    R76-15
Texas A&M University, Research Center
    R78-7
Texas reclamation
    R75-155
Throw-it-over-your-shoulder mining method
    R70-8
Tioga County, Pennsylvania, Demonstration Project
    R77-34
Todd Giddings and Associates, State College, Pennsylvania
    R76-32
Topography of reclaimed areas
    R75-156
Topsoil (See also Soil)
    R73-138
    effects of thickness and quality on vegetative response
        R76-73
    reconstruction
        R74-58
    seed source for revegetation
        R75-82
    storage, effect on soil microorganisms
        R76-63
Tower excavator mining
    R76-15
Toxicity; See Aluminum --; Manganese--; Spoil --
Trace elements; See Lichen, accumulation of metals from acid spoils
Tradewater River, Kentucky
    R72-23
Tree establishment (See also Alder; Apple trees; Arnot bristly locust; Beech; Black locust; Black walnut; Browsed pine; Conifers; Container-grown seedlings; Corsican pine; European alder; Fruit trees; Hybrid poplar; Loblolly pine; Nut trees; Peach trees; Pines; Ponerosa pine; Red pine; Seeding; Virginia pine; Wooded waterways)
    R47-1    R47-2    R48-2    R51-1    R53-1    R54-3    R55-1
    R57-3    R59-2    R59-3    R60-6    R62-1    R64-20
    affected by ground cover
        R68-12    R73-156    R73-157
    Alabama
        R76-56
    Cape Breton, Canada
        R74-80

Tree establishment (continued)
  effects of grading spoil banks on
    R67-14
  Illinois
    R78-2
  Indiana
    R43-1 R46-2 R48-6 R49-7 R49-8 R49-9
    R50-3 R54-5 R54-6 R62-14 R64-28 R69-22
    R71-49 R71-50
  Kansas
    R54-1 R62-11 R73-60 R78-12
  Kentucky
    R60-11 R74-123 R75-131
  Ohio
    R58-6 R63-6 R64-24 R69-16 R70-20 R73-57
    Kehota Area, Perry County
    R44-2
  Pennsylvania
    R48-1 R52-1 R57-2 R58-3 R59-4 R62-6
    R63-3 R63-17 R64-5 R64-43 R65-16 R68-5
    R68-13 R71-20 R71-21 R72-13 R73-2 R74-52
    on anthracite spoils
    R63-5 R66-3 R69-7 R70-4 R73-41
    plantings with grasses and legumes
    R76-98
    pulpwood production
    R64-8 R64-27
  West Virginia
    R55-5 R62-4 R63-20 R72-6
  with mycorrhizae in Ohio, Virginia, and Kentucky
    R75-115
    in Pennsylvania
    R76-62
  Wyoming
    R66-9 R75-128
Tree-planting guides
  R42-1 R63-9
Truax-Traer Coal Company; See Consolidation Coal Company
Turbidity reduction
  R73-84 R73-85 R74-27

Underground drainage; See Hydrology
The United Electric Coal Companies, Chicago, Illinois
  R50-2 R63-16 R64-41 R69-6
United States, mining and reclamation review (See also Land use, statistics on land mined and reclaimed)
  R75-129
United States Steel Corporation, Pittsburgh, Pennsylvania
  R71-33 R72-6 R73-118 R74-62

United States Steel Corporation, Pittsburgh, Pennsylvania (continued)
      Gary District, McDowell County, West Virginia
            R71-51
University of; See other part of name
Usibelli Coal Mine, Inc., Alaska
   R72-53
Utah Development Company, Australia
   R77-73
Utah International, Inc., San Francisco, California
      Goonyella Mine, Australia
            R72-61
      Navajo Mine, Fruitland, New Mexico
            R74-6   R74-63   R75-2   R75-68   R76-2   R77-1
            R78-7
Utah State University, Logan
   R72-18

Vacuumed soil for seed collection
   R75-143
Valley Camp Coal Company, Cleveland, Ohio
      West Virginia mines
            R73-153   R73-154   R74-55
Valley-fill method
   R70-8   R73-34   R74-10   R74-11   R74-69   R76-11   R76-34
      West Virginia specifications for
            R75-20
Vecellio & Grogan, Inc., West Virginia
   R77-61
Vegetation for reclaiming mined land
   R75-123   R76-96
      Kentucky, western coal field
            R77-68
      Montana
            R74-114
      recommended by the Soil Conservation Service
            R77-12
      wildlife management
            R56-7
Vegetation guides (See also Manual for establishment of vegetation on mined land)
      Kentucky
            R64-36   R73-78   R74-48
      Ohio
            R69-25
      Pennsylvania
            R71-17
      Virginia
            R64-1
      western United States
            R74-110

GENERAL INDEX

Vegetation on acid spoil
R62-3 R63-20 R70-16 R71-43
  evaluation of acid spoil ability to support plant growth
    R73-27
  manganese and aluminum toxicity
    R73-16
  Virginia pine adapted for acid spoil
    R73-107
Vegetation on reclaimed mined land (See also Irrigation; Mycorrhizae; Plant ecology; Planting methods; Row crops; Seeds; Soil; Tree establishment; Topsoil; Vegetative cover measurement; Wheat)
R71-51 R76-14
  Appalachia
    R76-7
  Colorado
    R75-84
  Kentucky
    R77-3
  Montana
    R75-93 R75-141
  New Mexico
    R75-75
  North Dakota
    R75-154
  Northern Great Plains
    R74-122
  Texas
    R75-155
  Washington
    R75-118
  West Virginia
    R71-51
  Wyoming
    R75-112
Vegetation on refuse banks
R73-175
Vegetation on spoil banks (See also Alberta, Canada, --; Alkali sacaton; Bermudagrass; Berries; Crownvetch; Fertilizer requirements; Forage crops; Fourwing saltbush; Grasses; Leaf litter decomposition; Legumes; Mountain rye; Mycorrhizae; Natural plant succession; Palar lovegrass; Poland, vegetation studies on amended spoils: Saskatchewan, Canada; Tall fescue; Tree establishment; Vineyards; Weeping lovegrass)
R28-1 R41-1 R42-2 R48-3 R49-3 R49-4 R49-5
R50-1 R52-4 R55-2 R57-5 R58-4 R60-9 R64-32
R65-20 R66-15 R71-30 R72-52 R73-18 R73-108 R73-175
  aids to establishing plants (See also Fertilizers; Latex as soil stabilizer; Mulches; Seed ledges; Seeding; Soil stabilizers)
    R69-14 R73-19 R73-110
  Alabama
    R73-12 R73-13

Vegetation on spoil banks (continued)
  Colorado
    R73-15
  eastern United States
    R76-13
  evaluation of plants for critical sites
    R73-128
  Germany
    R73-47
  heat injury to, from surface temperature of spoil
    R73-50
  Illinois
    Grundy County
    R76-45
    Perry County
    R56-6
  Indiana
    R68-16 R73-89
  Iowa
    R55-6 R77-8
  Montana
    R72-26
  New Mexico
    R75-1
  North Dakota
    R73-188
  Ohio
    R47-4 R57-8
  Pennsylvania
    R68-8 R72-5 R72-63 R73-90
  plant performance studies, Soil Conservation Service
    R78-10
  prediction of plant growth by soil testing
    R73-14
  seasonal planting effects on
    R73-48 R74-105
  species characteristics
    R77-27
  West Virginia
    R66-11 R73-19
  Wyoming
    R68-6 R71-23 R77-39
Vegetation on toxic spoil
  R71-43
  Ohio
    R73-146 R73-147
Vegetative cover measurement
  R77-7
Vegetative Rehabilitation and Equipment Workshop
  R75-64

## GENERAL INDEX

Vegetative succession (See also Natural plant succession; Pioneer vegetation)
R73-22
Vertical shaft excavation and spoil placement
R77-84
Vineyards
R75-61 R77-57
Virginia Department of Conservation
R75-73
Virginia pine
R73-107 R74-98
Virginia Polytechnic Institute and State University, Blacksburg
R72-69 R74-117 R75-49 R76-40 R77-69
Virginia reclamation (See also Lonesome Pine Soil Conservation District; Wildlife on surface-mined land, Hagy Wildlife Management Area)
R75-73 R75-123 R77-69
Wise County
R73-132 R75-27
Virginia Water Control Board
R77-34

W. A. Wahler & Associates, Palo Alto, California
R75-13
Wallick Coal, Inc., Strasburg, Ohio
R64-18
Washington Irrigation & Development Company, Centralia, Washington
Centralia Coal Mine
R73-84 R73-85 R74-27
Washington (state of) reclamation
R75-118
Water for Energy Management Team, U.S. Department of the Interior
R75-53
Water handling (See also Drainage control)
R44-1 R54-2 R64-11 R66-4 R71-5
Water harvesting (See also Black Mesa, Arizona, multiple land use, with--)
with wax and silicone
R76-84
Water infiltration
wettability of spoils, Fruitland formation, New Mexico
R77-59
effects of wetting agents
R78-7
Water management
R76-79
Water Programs, Office of, U.S. EPA
R71-16
Water quality (See also Acid mine drainage; Golf courses; Mathematical model,--)
R71-1 R75-35
Clear Creek Swamp and the Palzo Project
R75-114

Water quality (continued)
control
R73-114
Illinois
R74-70
Kentucky
R73-143
North Appalachian Experimental Watershed
R77-29
Ohio
R73-155 R74-1 R74-34
Powder River Basin
R75-133
turbidity control
R75-118
West Virginia
R75-47
Water Quality, Office of, U.S. EPA
R72-58
Water requirements for energy production
R75-53 R75-59
Water Resources Research, Office of, U.S. Department of the Interior
R71-37
Water retention in spoil
R65-23
Weeping lovegrass
R72-17 R74-116
D. G. Wertz Coal Co., Renovo, Pennsylvania
R62-9
West Branch Susquehanna River, Pennsylvania
R73-5
West Coal Corporation, Oneida, Tennessee
R75-29
West Virginia Department of Natural Resources
Drainage handbook for surface mining
R75-20
West Virginia reclamation (See also Cabin Creek demonstration project; Elkins demonstration project; Land use,--; Steep slope mining; Tree establishment; Vegetation on spoil banks; Wildlife on surface-mined land)
R45-1 R48-3 R55-5 R60-1 R62-3 R65-25 R66-20
R71-51 R72-16 R72-46 R73-17 R73-34 R73-72 R73-76
R73-99 R73-117 R73-159 R73-160 R73-184 R74-12 R74-71
R75-30 R76-35 R76-59 R76-92 R77-10 R77-11 R77-61
Dents Run
R75-34
Laurel Run
R75-33
the Stanford Report
R72-57 R73-145

West Virginia regulations
    head-of-hollow fills
        R76-80
West Virginia spoil characterization
  R73-111
West Virginia Surface Mining and Reclamation Association, Charleston
  (See also Longwall surface mining)
  R72-36  R73-162  R74-94  R75-50  R76-17
West Virginia University Foundation
    bibliography
        R73-97
West Virginia University, Morgantown
  R76-71
    Agricultural Experiment Station
        R45-1  R48-3  R55-5  R57-5  R60-1  R62-4
        R63-15  R66-11  R71-35  R73-19  R74-47  R75-58
        R76-87
    Appalachian Center
        R68-3
    College of Agriculture and Forestry
        R71-16  R74-88  R76-90
Western Energy Company, Butte, Montana
  R78-4
    Rosebud (Colstrip) Mine, Colstrip, Montana
        R72-25  R73-39  R73-40  R75-109  R75-119
Western Illinois University, Macomb
  R75-12
Western Interior Coal Province (See also Mid-west reclamation)
  R51-2
Western United States coal fields (See also Arid land reclamation; Northern
  Great Plains; Peabody Coal Co.; See under names of western states)
  R69-11  R70-9  R73-28  R73-139  R74-43  R75-14  R75-22
  R75-59  R75-79  R75-88  R75-152  R75-153  R76-96  R77-41
    costs of reclamation
        R77-66
    hydrology, mathematical model
        R76-38
    natural plant succession
        R77-23
    reclamation planning
        R76-75
    reclamation potential, study of
        R74-126
    soil analysis methods
        R78-11
    southwestern area (See also Black Mesa)
        R78-1
Westinghouse Electric Corporation, Pittsburgh, Pennsylvania
    Environmental Systems Department
        R76-97

Westmoreland Resources, Billings, Montana
    Absaloka Mine, Hardin, Montana
        R75-108
Wheat, yield from mined and unmined land compared
  R76-21
Wildlife affected by surface mining
  R68-1
Wildlife on coal lands
    mined and unmined areas, Iowa
        R76-42
Wildlife on reclaimed land (See also Canadian geese; Rodent population survey)
  R54-4 R56-5 R57-3 R63-14 R65-9 R68-5 R73-67
    North Dakota
        R67-2
    Pennsylvania
        R75-10
Wildlife on surface-mined land (See also Birds; Bobwhite quail; Fauna; Fur-bearing mammals; Mice; Muskrats)
  R52-4 R57-1 R58-4 R59-5 R59-6
    Hagy Wildlife Management Area, Virginia
        R73-58
    Illinois
        R56-8
    Kentucky
        R56-7 R77-76
    Ohio
        R47-4 R57-8
    small mammals
        R73-96
        Iowa
        R77-83
        Montana
        R75-117
    West Virginia
        R76-90
Will Scarlet Mine, Illinois
  R72-74
George Wimpey & Company, London, England
  R75-120
Wisconsin, University of, Milwaukee
  R75-80
Wooded waterways, Northern Great Plains
  R77-65
Wyodak Resources Development Corp., Gillette, Wyoming
    Wyodak Mine
        R71-24 R77-39
Wyoming Environmental Institute
    base-line studies, Powder River Basin
        R75-23

Wyoming, Gillette area, Campbell County
  hydrology-geology survey
    R76-52
Wyoming legislation
  R69-11 R70-7
Wyoming reclamation (See also Kemmerer Coal Company; Tree establishment, Wyoming; Vegetation on spoil banks, Wyoming; Wyoming, University of)
  R70-13 R71-24 R74-28 R74-101 R75-70 R75-112 R75-128
  R76-55 R77-40 R77-80
Wyoming spoil characterization
  R75-70
Wyoming, University of, Laramie (See also Wyoming Environmental Institute)
  Agricultural Experiment Station
    R71-23 R75-82
  Plant Sciences Division
    R66-9 R68-6 R69-14 R69-19
  Water Resources Research Institute
    R73-32 R75-135

Yellowstone River Basin
  R75-53
York, University of, United Kingdom
  R73-27
Yorkshire, England, reclamation
  R61-11
Yugoslavia reclamation
  R73-52

# APPENDIX I

## COAL AND THE ENVIRONMENT ABSTRACT SERIES: MINE DRAINAGE BIBLIOGRAPHY

ACID MINE DRAINAGE TREATS SEWAGE DUMPED IN STREAMS Coal Age 82 (11), 23 (Nov. 1977). Jour

AUTOMATIC WATER-TREATMENT PLANT Colliery Guardian 225 (10), 794-795 (October 1977). Jour

Barton, P. and Vatanatham, T. (The Pennsylvania State University), KINETICS OF LIMESTONE NEUTRALIZATION OF ACID WATERS Environmental Science & Technology 10 (3), 262-266 (March 1976). Jour

Brenner, F. J., Cooper, W. L., and MacHose, C. L. (Grove City College), EFFECT OF TEMPERATURE AND FERRIC HYDROXIDE ON THE EMBRYONIC AND PROTEIN DEVELOPMENT OF THE COHO SALMON, ONCORHYNCHUS KISUTCH Proceedings of the Pennsylvania Academy of Science 50, 165-169 (1976). CE578

Brenner, F. J., Corbett, S., and Shertzer, R. (Grove City College), EFFECT OF FERRIC HYDROXIDE SUSPENSION ON BLOOD CHEMISTRY IN THE COMMON SHINER, NOTROPUS CORNUTUS Transactions of the American Fisheries Society 105 (3), 450-455 (May 1976). CE573

Cairney, T. and Hamill, L. (Teesside Polytechnic, U.K.), INTERCONNECTION OF SURFACE AND UNDERGROUND WATER RESOURCES IN SOUTHEAST DURHAM J. Hydrology 33 (1/2), 73-86 (1977). CE485

Cooke. W. B., FUNGI IN AND NEAR STREAMS CARRYING ACID MINE-DRAINAGE Ohio J. Science 76 (5), 231-240 (1976). CE552

Coutant, C. C., Wasserman, C. S., Chung, M. S., Rubin,D. B., and Manning, M. (Oak Ridge National Laboratory), CHEMISTRY AND BIOLOGICAL HAZARD OF A COAL ASH SEEPAGE STREAM J. Water Pollution Control Federation 50 (4), 747-753 (April 1978). Jour

Davis, R. W., Plebuch, R. O., and Whitman, H. M., HYDROLOGY AND GEOLOGY OF DEEP SANDSTONE AQUIFERS OF PENNSYLVANIAN AGE IN PART OF THE WESTERN COAL FIELD REGION, KENTUCKY U.S. Geological Survey, in cooperation with Kentucky Geological Survey, Series X, Report of Investigations 15 (1974). 26 pp. + maps. 550. K37

DENT'S RUN CLEAN-UP COMPLETED Green Lands 6 (1), 6-9 (Winter 1976). Jour

DEPENDABLE SUBMERSIBLE PUMPS DEWATER THREE KAISER MINES Coal Mining Process. 15 (2), 74-76 (Feb. 1978). Jour

Dettmann, E. H. and Olsen, R. D. (Argonne National Laboratory), ASSESSMENT OF WATER QUALITY IMPACTS OF A WESTERN COAL MINE in "Reclamation of Disturbed Arid Lands," R. A. Wright, Ed., Albuquerque: University of New Mexico Press, 1978. pp 53-67. CE547

Double, M. L., Savio, J. A., and Bissonnette, G. K., RECOVERY OF SANITARY-INDICATOR BACTERIA FROM STREAMS CONTAINING ACID MINE WATER West Virginia University Bulletin, Series 78, No. 10-7 (April 1978). West Virginia University, Water Research Institute, Information Report 11, WRI-WVU-78-02 (1978). 30 pp. CE569

Dreese, G. R. (1) and Bryant, H. L. (2) [(1) West Virginia University and (2) Xavier University], COSTS AND EFFECTS OF A WATER PROGRAM FOR A SMALL STRIPPING COMPANY--SOUTHEASTERN OHIO Water Resources Bulletin 8 (2), 320-327 (April 1972). CE579

Dvorak, A. J., Lewis, B. G., et al., IMPACTS OF COAL-FIRED POWER PLANTS ON FISH, WILDLIFE, AND THEIR HABITATS Argonne National Laboratory, Report to U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-78/29 (March 1978). 262 pp. NTIS, PB-283 658. CE567

Dyer, K. L. and Curtis, W. R., EFFECT OF STRIP MINING ON WATER QUALITY IN SMALL STREAMS IN EASTERN KENTUCKY, 1967-1975 U.S. Forest Service Research Paper NE-372 (1977). 13 pp. CE553

Dyer, R. (Western Kentucky University), THE EFFECTS OF MINE ACID ON THE POND RIVER WATERSHED IN WESTERN KENTUCKY Water Resources Bulletin 13 (5), 1069-1074 (Oct. 1977). CE559

Eikenberry, S. E., A WATER-QUALITY ASSESSMENT OF THE BUSSERON CREEK WATERSHED, SULLIVAN, VIGO, GREENE, AND CLAY COUNTIES, INDIANA U.S. Geological Survey, Indianapolis, Indiana, in cooperation with the U.S. Department of Agriculture, Soil Conservation Service, Open-File Report 78-13 (Jan. 1978). 36 pp. CE549

ENVIRONMENTAL ASPECTS OF THE NEW-SOURCE NPDES PERMIT PROGRAM FOR THE WEST VIRGINIA SURFACE COAL MINING INDUSTRY, 1977-1980 Jack McCormick & Associates, Inc., A Subsidiary of WAPORA, Inc., Final Report to U.S. EPA Region III, EPA-903/9-78-002 (March 1977). 219 pp. NTIS, PB-277 974. CE562

Frost, R. C., THE VARIABLE IRON CONTENT OF MINE FLOOD WATER: IMPLICATIONS FOR SAMPLING AND POLLUTION CONTROL Colliery Guardian International 226 (10), 36-38 (Oct. 1978). Jour

Frost, R. C., VARIATIONS IN THE IRON CONTENT OF SOME OUTCROP WATERS IN SOUTH DURHAM Colliery Guardian 226 (5), 233-234 (May 1978). Jour

Gleason, V. E., Price, A., Boyer, J. F., Jr., and Ford, C. T., ASSESSMENT OF RESEARCH AND DEVELOPMENT NEEDS AND PRIORITIES FOR ACID MINE DRAINAGE ABATEMENT Bituminous Coal Research, Inc., Report to U.S. Bureau of Mines, Office of the Assistant Director--Mining, BCR-L-822, BuMines-OFR-44-78 (Feb. 1978). 169 pp. NTIS, PB-282 440/7WP. CE166

Grady, W. C. (West Virginia University, Coal Research Bureau), MICROSCOPIC VARIETIES OF PYRITE IN WEST VIRGINIA COALS Trans. AIME 262 (1), 268-274 (March 1977). Jour

Hackney, C. R. and Bissonnette, G. K. (West Virginia University), RECOVERY OF INDICATOR BACTERIA IN ACID MINE STREAMS J. Water Pollution Control Federation 50 (4), 775-780 (April 1978). Jour

Harrison, J. E., COAL MINING AND SURFACE WATER QUALITY: CROWSNEST PASS, ALBERTA AND BRITISH COLUMBIA - PRELIMINARY DATA in Geological Survey of Canada, Report of Activities Part A, Paper 77-1A (1977). pp 319-322. Available, Geological Survey of Canada, 601 Booth Street, Ottawa, K1A 0E8. $7.20 outside of Canada. 550. C212

Henry, J. D., Jr. and Kuo, C. H. A., AN EVALUATION OF THE APPLICATION OF A DUAL-FUNCTIONAL FILTER TO DEWATERING NEUTRALIZED ACID-MINE-WATER SLUDGE West Virginia University Bulletin, Series 78, No. 10-6 (April 1978). West Virginia University, Water Research Institute, Information Report 10, WRI-WVU-78-01 (1978). 55 pp. CE557

Henton, M. P., PREDICTING THE QUALITY OF MINE WATER DISCHARGES Effluent and Water Treatment J. 16 (11), 568, 572 (Nov. 1976). CE574

Herricks, E. E. (1) and Cairns, J., Jr. (2) [(1) University of Illinois and (2) Virginia Polytechnic Institute and State University], THE EFFECTS OF LIME NEUTRALIZATION OF ACID MINE DRAINAGE ON STREAM ECOLOGY in "Proceedings of the 32nd Industrial Waste Conference, May 10, 11 and 12, 1977, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1978. pp 477-486. 628.2 I323

Hill, R. D. and Bates, E. R., ACID MINE DRAINAGE AND SUBSIDENCE: EFFECTS OF INCREASED COAL UTILIZATION U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series, EPA-600/2-78-068 (April 1978). 30 pp. NTIS, PB-281 092/7BE. CE565

Hocutt, C. H., Dickson, K. L., Masnik, M. T., and Stauffer, J. R. (Virginia Polytechnic Institute and State University), OBSERVATIONS OF AN ASH LAGOON SPILL ON THE NEW RIVER, VIRGINIA Hydrobiologia 48 (3), 241-245 (1976). CE564

HOW MINE WATER IS CLARIFIED AT SILVERDALE COLLIERY Mine and Quarry 6 (7/8), 6, 8 (July/Aug. 1977). Jour

Jacobsen, J., MOBILIZATION, TRANSPORTATION AND SEDIMENTATION OF WEATHERING PRODUCTS FROM THE ABANDONED BROWN-COAL PITS. (IRON POLLUTION OF THE RIVER SKJERNÅ AND RINGKØBING FJORD, WESTERN JUTLAND) Danmarks Geologiske Undersogelse, Arbog, pp 57-74, 1975 (Published 1976). CE571

James, I. C., II (1) and Steele, T. D. (2) [U.S. Geological Survey (1) Reston, Va. and (2) Lakewood, Colo.], APPLICATION OF RESIDUALS MANAGEMENT FOR ASSESSING THE IMPACTS OF ALTERNATIVE COAL-DEVELOPMENT PLANS ON REGIONAL WATER RESOURCES Third International Hydrology Symposium, Colorado State University, Fort Collins, Colorado, June 27-29, 1977. 23 pp. CE529

James, W. P., Slowey, J. F., Garrett, R. L., Ortiz, C., Bright, J., and King, T., POTENTIAL IMPACT OF THE DEVELOPMENT OF LIGNITE RESERVES ON WATER RESOURCES OF EAST TEXAS Texas A&M University, Water Resources Institute, Research Project Completion Report, Project No. B-199-TEX, July 1, 1976-August 31, 1976, Technical Report No. 78 (Aug. 1976). 179 pp. NTIS, PB-263 492. CE577

Knapton, J. R. and McKinley, P. W., WATER QUALITY OF SELECTED STREAMS IN THE COAL AREA OF SOUTHEASTERN MONTANA U.S. Geological Survey, Water Resources Division, Helena, Montana, USGS/WRD/WRI-77/062, USGS/WRI-77-80 (Sept. 1977). 145 pp. NTIS, PB-273 028. US Geol

Knight, A. L. and Newton, J. G., WATER AND RELATED PROBLEMS IN COAL-MINE AREAS OF ALABAMA U.S. Geological Survey, Water Resources Division, USGS/WRI-76-130, USGS/WRD/WRI-77/051 (April 1977). 51 pp. NTIS, PB-271 527. CE36

Koryak, M., Shapiro, M. A., and Sykora, J. L. (University of Pittsburgh), RIFFLE ZOOBENTHOS IN STREAMS RECEIVING ACID MINE DRAINAGE Water Research *6* (10), 1239-1247 (1972). CE299

Kristiansen, H., HYDROCHEMISTRY OF THE DRAINED SKJERNÅ DELTA. (IRON POLLUTION OF THE RIVER SKJERNÅ AND RINGKØBING FJORD, WESTERN JUTLAND) Danmarks Geologiske Undersogelse, Arbog, pp 45-55, 1975 (Published 1976). CE572

Kugatow, M. A., MEDIATION OF ACID STRIP MINE POLLUTION BY THE ATTEMPTED INHIBITION OF THE IRON-OXIDIZING AUTOTROPH, *THIOBACILLUS FERROOXIDANS* D.Ed. Thesis, The Pennsylvania State University, 1977. 62 pp. University Microfilms, 78-3339. 628.2 K95

Leung, S. S. and Hester, N. C., EVALUATION OF THE VOLUMES AND CHARACTERISTICS OF MINE WASTE EFFLUENTS OF THREE STRIP MINE LOCALITIES IN EASTERN KENTUCKY AND THEIR POTENTIAL ENVIRONMENTAL IMPACTS Eastern Kentucky University, Final Report, Covering the Period of Jan. 1, 1976 through June 30, 1977, to Argonne National Laboratory, Research Contract No. 31-109-38-3375, January 1978. (297 pp). CE546

Libicki, J., EFFECTS OF THE DISPOSAL OF COAL WASTE AND ASHES IN OPEN PITS Central Research and Design Institute for Open-pit Mining, POLTEGOR, Interagency Energy-Environment Research and Development Program Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, EPA-600/7-78-067 (April 1978). 282 pp. EPA

McElroy, A. D., Chiu, S. Y., Nebgen, J. W., Aleti, A., and Vandegrift, A. E., (Midwest Research Institute), WATER POLLUTION FROM NONPOINT SOURCES Water Research 9 (7), 675-681 (1975). CE560

Metry, A. A. (Roy F. Weston, Inc.), TREATABILITY AND TREATMENT OF LEACHATE AND CONTAMINATED RUN-OFF WATERS FROM A COAL TRANSSHIPMENT FACILITY in "Proceedings of the 30th Industrial Waste Conference, May 6, 7 and 8, 1975, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1977. pp 198-206. 628.2 I323

MINE DRAINAGE ABATEMENT INVESTIGATIONS: NORTHWEST ALLEGANY COUNTY AND LOWER GEORGES CREEK COMPLEX, ALLEGANY AND GARRETT COUNTIES, MARYLAND Green Associates, Inc. and Gannett Fleming Corddry and Carpenter, Inc., Report to Maryland Department of Natural Resources, Nov. 1972. Submitted Dec. 31, 1974. (179 pp. + 11 plates). 628.2 G79

Minear, R. A. and Tschantz, B. A. (University of Tennessee), THE EFFECT OF COAL SURFACE MINING ON THE WATER QUALITY OF MOUNTAIN DRAINAGE BASIN STREAMS Journal Water Pollution Control Federation 48 (11), 2549-2569 (Nov. 1976). Jour

Minear, R. A., Tschantz, B. A., Rule, J. H., Vaughan, G. L., Overton, D. E., and Briggs, G., ENVIRONMENTAL ASPECTS OF COAL PRODUCTION IN THE APPALACHIAN REGION University of Tennessee Environment Center, Appalachian Resources Project, Progress Report June 1, 1976 - May 31, 1977 to U.S. Energy Research and Development Administration, ORO-4946-2 (undated). CE482

Myers, P. S. and Millar, W. N. (West Virginia University), NONAUTOTROPHIC *THIOBACILLUS* IN ACID MINE WATER Applied Microbiology 30 (5), 884-886 (Nov. 1975). CE576

NCB WATER TREATMENT PLANT NEEDS NO LAGOONS Coal Age 82 (7), 21 (July 1977). Jour

Napier, S., Jr. and Hummon, W. D. (Ohio University, Athens), SURVIVAL OF MAYFLY LARVAE UNDER MINE ACID CONDITIONS Int. Revue ges. Hydrobiol. 61 (5), 677-682 (1976). CE554

NEW PLANT FILTERS 400 GAL/MIN. OF MINE WATER Filtration & Separation 14 (4), 414 (July/Aug. 1977). CE484

Orciari, R. D. and Hummon, W. D. (Ohio University, Athens), A COMPARISON OF BENTHIC OLIGOCHAETE POPULATIONS IN ACID AND NEUTRAL LENTIC ENVIRONMENTS IN SOUTHEASTERN OHIO Ohio J. Science 75 (1), 44-49 (Jan. 1975). CE555

Peters, T. W., MINE DRAINAGE PROBLEMS IN NORTH DERBYSHIRE The Mining Engineer 137 (200), 463-473 (March 1978). Jour

Pisapia, R., Kopyta, F., and Keller, E. C., Jr. (West Virginia University), *CHLORELLA VULGARIS* GROWTH RESPONSE TO ACID MINE WATER STRESS UNDER CONDITIONS OF CONSTANT AND REDUCED LIGHT West Virginia Academy of Science Proceedings, Biology Section 45 (2), 120-127 (1973). CE581

Porter, K. R. and Hakanson, D. E., TOXICITY OF MINE DRAINAGE TO EMBRYONIC AND LARVAL BOREAL TOADS (BUFONIDAE: *BUFO BOREAS*) Copeia, No. 2, 327-331, 1976. CE561

Reed, G. D. (1), Mitchell, D. T. (2), and Parker, D. G. (2) [(1) University of Missouri and (2) University of Arkansas], WATER QUALITY EFFECTS OF AQUEOUS FLY ASH DISPOSAL in "Proceedings of the 31st Industrial Waste Conference, May 4, 5 and 6, 1976, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1977. pp 337-343. 628.2 I323

Renton, J. J. and Hidalgo, R. V., SOME GEOCHEMICAL CONSIDERATIONS OF COAL West Virginia Geological and Economic Survey, Coal-Geology Bulletin No. 4 (Aug. 1975). 38 pp.+ WVa

Schrader, E. L., Jr. (1), Rule, J. H. (2), and Furbish, W. J. (1) [(1) Duke University and (2) University of Tennessee], TRACE METAL GEOCHEMISTRY OF A FLUVIAL SYSTEM IN EASTERN TENNESSEE AFFECTED BY COAL MINING Southeastern Geology 18 (3), 157-172 (1977). CE566

SETTLER'S CABIN PARK: AN ENVIRONMENTAL ASSESSMENT OF MINE DRAINAGE POLLUTION Ackenheil & Associates Geo Systems, Inc., Report to Appalachian Regional Commission, GEO Project 75100, Aug. 16, 1976. 49 pp.+ NTIS, PB-261 593/8BE CE225

Shotts, R. Q., Sterett, E., and Simpson, T. A., SITE SELECTION AND DESIGN FOR MINIMIZING POLLUTION FROM UNDERGROUND COAL MINING OPERATIONS The University of Alabama, Interagency Energy-Environment Research and Development Program Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, EPA-600/7-78-006 (Jan. 1978). 98 pp. NTIS, PB-280 180/1WN. CE548

Sisler, F. D. and Senftle, F. E. (to The United States of America as represented by the Secretary of the Interior), BIOELECTRIC NEUTRALIZATION OF ACID WATERS U.S. Pat. 4,072,798 (Feb. 7, 1978). 7 pp. US Pat

Smith, E. J. (1) and Sykora, J. L. (2) [(1) U.S. Army Engineer District, Pittsburgh and (2) University of Pittsburgh], EARLY DEVELOPMENTAL EFFECTS OF LIME-NEUTRALIZED IRON HYDROXIDE SUSPENSIONS ON BROOK TROUT AND COHO SALMON Transactions of the American Fisheries Society 105 (2), 308-312 (1976). CE575

Smith, G. V. (1), Liu, J.-H. (1), Saporoschenko, M. (1), and Shiley, R. (2) [(1) Southern Illinois University and (2) Illinois State Geological Survey], MÖSSBAUER SPECTROSCOPIC INVESTIGATION OF IRON SPECIES IN COAL Fuel 57 (1), 41-45 (Jan. 1978). Jour

Steele, T. D. (U.S. Geological Survey, Lakewood, Colorado), ASSESSMENT TECHNIQUES FOR MODELING WATER QUALITY IN A RIVER BASIN AFFECTED BY COAL-RESOURCE DEVELOPMENT Symposium on Modelling the Water Quality of the Hydrological Cycle, Baden, Austria, by International Association of Hydrological Sciences and International Institute for Applied Systems Analysis, Sept. 11-15, 1978. 16 pp. CE551

Stiller, A. H. (1), Renton, J. J. (1), Montano, P. A. (2), and Russell, P. E. (2) [(1) West Virginia Geological Survey and (2) West Virginia University], APPLICATION OF MÖSSBAUER SPECTROSCOPY TO MONITOR ACID MINE DRAINAGE POTENTIALS OF COAL SEAMS Fuel 57 (7), 447-448 (July 1978). Jour

Swarts, F. A., FACTORS INVOLVED IN THE RESISTANCE OF BROOK TROUT (*SALVELINUS FONTINALIS*) TO SULFURIC ACID SOLUTIONS AND MINE ACID POLLUTED WATERS M.S. Thesis, The Pennsylvania State University, 1977. 141 pp. NTIS, PB-282 102. CE550

Tackett, S. L. and Wieserman, L. F. (Indiana University of Pennsylvania), SIMULTANEOUS POLAROGRAPHIC DETERMINATION OF IRON (II) AND IRON (III) IN COAL MINE WASTE WATER Analytical Letters 5 (9), 643-651 (1972). CE580

Talbot, R. W., Anderson, M. A., and Andren, A. W. (University of Wisconsin, Water Chemistry Laboratory), QUALITATIVE MODEL OF HETEROGENEOUS EQUILIBRIA IN A FLY ASH POND Environmental Science & Technology 12 (9), 1056-1062 (Sept. 1978). Jour

Theis, T. L. and Richter, R. O. (University of Notre Dame), CHEMICAL SPECIATION OF HEAVY METALS IN POWER PLANT ASH POND LEACHATE 33rd Purdue Industrial Waste Conference, May 9-11, 1978. (29 pp). CE70

Theis, T. L., Westrick, J. D., Hsu, C. L., and Marley, J. J. (University of Notre Dame), FIELD INVESTIGATIONS OF TRACE METALS IN GROUND WATER FROM FLY ASH DISPOSAL in "Proceedings of the 32nd Industrial Waste Conference, May 10, 11 and 12, 1977, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1978. pp 332-344. 628.2 I323

Thurston, R. V., Skogerboe, R. K., and Russo, R. C., TOXIC EFFECTS ON THE AQUATIC BIOTA FROM COAL AND OIL SHALE DEVELOPMENT. PROGRESS REPORT--YEAR 2 (JULY 1976-JUNE 1977) Colorado State University, Natural Resource Ecology Laboratory, Internal Project Report No. 13 (Nov. 1977). 58 pp. CE556

Updegraff, K. F. and Sykora, J. L. (University of Pittsburgh), AVOIDANCE OF LIME-NEUTRALIZED IRON HYDROXIDE SOLUTIONS BY COHO SALMON IN THE LABORATORY Environmental Science & Technology 10 (1), 51-54 (Jan. 1976). Jour

USING FLOCCULANT ECONOMICALLY Mine and Quarry 6 (7/8), 63-64 (July/Aug. 1977). Jour

Villumsen, A., RECENT IRON-RICH SEDIMENTS IN THE SKJERNÅ RIVER SYSTEM AND IN RINGKØBING FJORD. (IRON POLLUTION OF THE RIVER SKJERNÅ AND RINGKØBING FJORD, WESTERN JUTLAND) Danmarks Geologiske Undersogelse, Arbog, pp 31-43, 1975 (Published 1976). CE570

Wachter, R. A. and Blackwood, T. R., SOURCE ASSESSMENT: WATER POLLUTANTS FROM COAL STORAGE AREAS Monsanto Research Corporation, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, EPA-600/2-78-004m (May 1978). 106 pp. EPA

Walker, B. N. (1) and Medve, R. J. (2) [(1) Cecil Community College and (2) Slippery Rock State College], THE EFFECTS OF ACID MINE DRAINAGE ON SPARGANIUM AMERCANUM NUTT. Proceedings of the Pennsylvania Academy of Science 50 (2), 170-172 (1976). CE558

Wallace, R. A. P., METHOD OF AND APPARATUS FOR REMOVING CONCENTRATED SOLUTIONS OF IONISABLE COMPOUNDS FROM AQUEOUS SOLUTIONS THEREOF Brit. Pat. 1,410,188 (Oct. 15, 1975). 22 pp. Brit Pat

Wangsness, D. J., PHYSICAL, CHEMICAL, AND BIOLOGICAL RELATIONS OF FOUR PONDS IN THE HIDDEN WATER CREEK STRIP-MINE AREA, POWDER RIVER BASIN, WYOMING U.S. Geological Survey, Water Resources Division, Cheyenne, Wyoming, USGS/WRD/WRI-77/072 (July 1977). 43 pp. NTIS, PB-273 512. US Geol

Wentz, D. A. and Steele, T. D. (U.S. Geological Survey, Lakewood, Colorado), SURFACE-WATER QUALITY IN THE YAMPA RIVER BASIN, COLORADO AND WYOMING--AN AREA OF ACCELERATED COAL DEVELOPMENT Conference on Water for Energy Development, Engineering Foundation, Asilomar Conference Grounds, Pacific Grove, California, Dec. 5-10, 1976. 28 pp. CE568

Whitworth, K., UNIQUE AUTOMATIC WATER TREATMENT PLANT AT SILVERDALE COLLIERY World Coal 4 (1), 20-22 (Jan. 1978). Jour

Wilmoth, R. C., COMBINATION LIMESTONE-LIME NEUTRALIZATION OF FERROUS IRON ACID MINE DRAINAGE U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series, EPA-600/2-78-002 (Jan. 1978). 52 pp. NTIS, PB-280 169/4WP. CE563

Wilmoth, R. C. (1), Scott, R. B. (1), and Harris, E. F. (2) [U.S. EPA, (1) Crown Field Site, Rivesville, West Virginia and (2) Industrial Environmental Research Laboratory, Cincinnati, Ohio], APPLICATION OF ION EXCHANGE TO ACID MINE DRAINAGE TREATMENT in "Proceedings of the 32nd Industrial Waste Conference, May 10, 11 and 12, 1977, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1978. pp 820-829. 628.2 I323

# APPENDIX II

## COAL AND THE ENVIRONMENT ABSTRACT SERIES: BIBLIOGRAPHY ON DISPOSAL OF REFUSE FROM COAL MINES AND COAL CLEANING PLANTS

Annen, G. and Stalmann, V., WASHERY DISCARD IN DIKE AND EMBANKMENT CONSTRUCTION Glückauf 105 (26), 1336-1343 (Dec. 25, 1969). National Coal Board, TRANS.A.2794/AL CE360

ATTACK ON THE PROBLEM OF COAL WASHERY WASTE Queensland Government Mining J. 78 (909), 337-338 (July 1977). CE609

Atwood, G., SURFACE AND UNDERGROUND DISPOSAL OF COAL MINE WASTES. PART 1: COAL WASTE PRODUCTION, SURFACE DISPOSAL AND REGULATION Underground Space 1 (2), 111-121 (1976). CE610

Atwood, G., SURFACE AND UNDERGROUND DISPOSAL OF COAL MINE WASTES. PART II - UNDERGROUND DISPOSAL Underground Space 1 (3), 261-281 (1977). CE611

Bell, F. G. (the Polytechnic, Sheffield, England), COARSE DISCARD FROM MINES Civil Engineering, March 1977. pp 37-39. CE341

Bennett, H. B. (National Coal Board, East Midlands Division), CONTINUOUS MINING WITH SOLID PNEUMATIC STOWING AT DONISTHORPE COLLIERY The Colliery Guardian 189 (4896), 811-819 (Dec. 30, 1954). D-202

Bland, A. E., Robl, T. L., and Rose, J. G. (University of Kentucky), EVALUATION OF INTERSEAM AND COAL CLEANING EFFECTS ON THE CHEMICAL VARIABILITY OF PAST AND PRESENT KENTUCKY COAL REFUSE Trans. AIME 262, 331-334 (Dec. 1977).

Browning, J. S., RECOVERING FINE-SIZE COAL FROM ALABAMA SURFACE MINE WASHER WASTES USING THE HUMPHREYS SPIRAL University of Alabama, Mineral Resources Institute and State Mine Experiment Station, MRI Technical Report Series, T.R. Number 2, 1977. 11 pp. CE607

Burgess, C. (Bethlehem Mines Corp.), COAL PREPARATION--1976 Mining Congr. J. 63 (2), 21-25 (Feb. 1977). Jour

Cass, B. E., Coate, D. W., and Quigley, J. R. (to Carad, Inc.), METHOD AND APPARATUS FOR RECOVERING BY-PRODUCT SILT FINES FROM A SLURRY THEREOF U.S. Pat. 4,003,717 (Jan. 18, 1977). 8 pp. US Pat

Chalekode, P. K. and Blackwood, T. R., SOURCE ASSESSMENT: COAL REFUSE PILES, ABANDONED MINES AND OUTCROPS, STATE OF THE ART Monsanto Research Corporation, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, EPA-600/2-78-004v (July 1978). 39 pp. EPA

Charlesworth, D., HOW WASTE LIME IS HELPING TO TRANSFORM COLLIERY TIPS INTO PRODUCTIVE GRASSLAND British Sugar Beet Review 44 (2), 18-20 (1976). CE351

Chen, C. Y. (1), Elnaggar, H. A. (2), and Bullen, A. G. R. (3) [(1) Michael Baker, Jr., Inc., (2) Orbital Engineering, and (3) University of Pittsburgh], DEGRADATION AND THE RELATIONSHIP BETWEEN SHEAR STRENGTH AND VARIOUS INDEX PROPERTIES OF COAL REFUSE Symposium on New Horizons in Construction Materials With Special Application to Geotechnical Engineering, Bethlehem, Pennsylvania, by Lehigh University, Nov. 1-3, 1976. (13 pp). CE416

Chironis, N. P., FROM UK: DEEP-CONE THICKENERS Coal Age 82 (10), 126-129 (Oct. 1977). Jour

Choudhry, V. (TISCO, Jamadoba, India), DISPOSAL OF REJECTS AND CONTROLLING REJECTS FIRES J. Mines, Metals & Fuels 25 (4), 122-124 (April 1977). CE599

A CLEANING PLANT VS. THE SKEPTICS Coal Age 82 (8), 48-52 (Aug. 1977). Jour

COAL WASTE PROCESSING PLANT PROFITABLY RECOVERS COAL AND BUILDING MATERIALS Organization for Economic Co-operation and Development - Technological Digests 9 (5), 45 (May 1964). CE340

COLLIERY SHALE - A NEW SOURCE OF BULK CONSTRUCTION MATERIAL Mining & Minerals Engineering 5 (6), 11 (June 1969). CE334a

Colman, R. B., COLLIERY SHALE--USEFUL IN FORMATION Civil Engineering, pp 66-67, July/Aug. 1977. CE586

Cook, R. L. (1) and Childress, J. J. (2) [(1) Parkson Corp. and (2) Childress Corp.], PERFORMANCE OF LAMELLA THICKENERS™ IN COAL PREPARATION PLANTS Mining Engineering 30 (5), 566-571 (May 1978). Jour

Cowherd, D. C. (BOWSER-MORNER Testing Laboratories, Inc.), GEOTECHNICAL CHARACTERISTICS OF COAL MINE WASTE Proceedings of the Conference on Geotechnical Practice for Disposal of Solid Waste Material, Univ. of Michigan, Ann Arbor, MI, June 13-15, 1977. pp 384-406 CE590

Czapowskyj, M. M. and Sowa, E. A., LIME HELPS ESTABLISH CROWNVETCH ON COAL-BREAKER REFUSE U.S. Forest Service Research Paper NE-348 (1976). 6 pp. R1025

Davies, W. E., Bailey, J. F., and Kelly, D. B., WEST VIRGINIA'S BUFFALO CREEK FLOOD: A STUDY OF THE HYDROLOGY AND ENGINEERING GEOLOGY U.S. Geological Survey, Circular 667 (1972). 32 pp. US Geol

Davis, H., COAL PREPARATION FOR GASIFICATION Coal Age 82 (5), 79-82 (May 1977). Jour

Davis, H., MONTEREY NO. 2 BUILDS TOWARD ITS TONNAGE GOAL Coal Age 82 (12), 96-100 (Dec. 1977). Jour

Dennington, V. N. and Chadwick, M. J. (University of York, U.K.), THE NUTRIENT BUDGET OF COLLIERY SPOIL TIP SITES. I. NUTRIENT INPUT IN RAINFALL AND NUTRIENT LOSSES IN SURFACE RUN-OFF J. Applied Ecology 15 (1), 303-316 (1978). CE593

Dick, J. B., Gutt, W., and Collins, R. J., BUILDING RESEARCH ESTABLISHMENT: SOME WORK IN PROGRESS: MINERALOGY OF COLLIERY SPOIL AND ITS UTILISATION Chemistry and Industry, pp 339-341, April 17, 1976. CE589

DONCASTER CARR PROJECT Surveyor 151 (4485), 16 (May 25, 1978). CE595

Down, C. G. (The University, Bristol, Great Britain), LIFE FORM SUCCESSION IN PLANT COMMUNITIES ON COLLIERY WASTE TIPS Environmental Pollution 5 (1), 19-22 (1973). CE606

Down, C. G. (The University, Bristol, Great Britain), THE RELATIONSHIP BETWEEN COLLIERY-WASTE PARTICLE SIZES AND PLANT GROWTH Environmental Conservation 1 (4), 281-284 (Winter 1974). CE649

FEASIBILITY STUDY OF UTILIZATION OF COAL MINE REFUSE, ESTILL COUNTY, KENTUCKY University of Kentucky, Research Foundation, Report to Bluegrass Area Development District, under contract with Appalachian Regional Commission, Project ARC 74-217-Ky-3685 (Aug. 1976). (269 pp). CE582

Fitter, A. H. and Bradshaw, A. D. (University of Liverpool, U.K.), ROOT PENETRATION OF LOLIUM PERENNE ON COLLIERY SHALE IN RESPONSE TO RECLAMATION TREATMENTS J. Applied Ecology 11 (2), 609-615 (1974). CE588

THE FUELS OUTLOOK: THE PENNSYLVANIA DEPT. OF TRANSPORTATION HAS DEVELOPED A PRACTICAL METHOD TO HELP ELIMINATE MINE WASTE BANKS IN ANTHRACITE AND BITUMINOUS COAL FIELDS Electrical World 188 (6), 72 (Sept. 15, 1977). Jour

Goodboy, K. P. (Alcoa Laboratories, East St. Louis, Ill.), INVESTIGATION OF A SINTER PROCESS FOR EXTRACTION OF $Al_2O_3$ FROM COAL WASTES in "Light Metals 1976. Vol. II. Alumina and Bauxite Production and Cast Shop Technology and Environmental Control," S. R. Leavitt, Ed., Proceedings 105th AIME Annual Meeting, Las Vegas, Nevada, (1976). pp 19-28. CE339. See D76-29 in Coal and the Environmental Abstract Series: A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants.

Grekhov, I. T., Itkin, Yu. V., Cherkinskaya, K. T., and Shpirt, M. Ya., INTERACTION OF LIMESTONE WITH THE MINERAL PART OF THE SULFUR-CONTAINING WASTES FROM COAL ENRICHMENT Solid Fuel Chemistry (Khimiya Tverdogo Topliva) 9 (5), 31-35 (1975). Jour

Guin, J. A., POLLUTION CONCENTRATIONS IN RUNOFF WATER FROM REFUSE PILES Auburn University, Water Resources Research Institute, Completion Report for OWRT Project DI-B-056-ALA, WRRI BULLETIN 26 (March 1977). 39 pp. CE598

Hampson, R. W., LAND RECLAMATION IN STOKE-ON-TRENT. PAPER TWO: CIVIL ENGINEERING ASPECTS Chartered Municipal Engineer 103 (10), 173-177 (Oct. 1976). CE335

Harrison, J. E., SUMMER SOIL TEMPERATURE AS A FACTOR IN REVEGETATION OF COAL MINE WASTE in Geological Survey of Canada, Report of Activities Part A, Paper 77-1A (1977). pp 329-332. Available, Geological Survey of Canada, 601 Booth Street, Ottawa, K1A OE8. $7.20 outside of Canada. 550. C212

Haynes, R. J. and Klimstra, W. D. (Southern Illinois University, Cooperative Wildlife Research Laboratory), SOME PROPERTIES OF COAL SPOILBANK AND REFUSE MATERIALS RESULTING FROM SURFACE-MINING COAL IN ILLINOIS Illinois Institute for Environmental Quality, IIEQ Doc. No. 75-21 (Oct. 1975). 126 pp. NTIS, PB-251 184. See R75-103 of this volume for abstract. R777

Hodgkinson, D. R. (National Coal Board, Western Area), PUMP-PACKING SYSTEMS AT FLORENCE COLLIERY The Mining Engineer 136 (195), 707-716 (Aug./Sept. 1977). Jour

Hodgkinson, N., Pritchard, F. W., and Lewis, S. [to Coal Industry (Patents) Ltd.], A COMPOSITE MATERIAL Brit. Pat. 1,473,517 (May 11, 1977). 3 pp. Brit Pat

Howard, G. G., A LABORATORY INVESTIGATION OF THE PROPERTIES OF COAL-BITUMEN PAVING MIXTURES University of Kentucky, Engineering Experiment Station, Bulletin No. 71 (March 1964). 46 pp. CE604

Iryo, M. (to Asia Technical Consultant Co.), SYNTHESIS OF LIGHTWEIGHT AGGREGATES FROM LOW CALORIC WASTE COAL DUST Japanese Kokai 73-79821 (Oct. 26, 1973). 4 pp. J Pat

James, J. G. and Broad, B. A., CONVEYING LIMESTONE AGGREGATES AND COLLIERY SPOIL BY HYDRAULIC PIPELINE: TRIALS WITH A 156MM DIAMETER PIPE Transport and Road Research Laboratory, Crowthorne, England, TRRL-SUPPLEMENTARY-354 (1978). 46 pp. NTIS, PB-279 131. CE596

Japp, F. and Hilton, R. (to Gullick Dobson Ltd.), IMPROVEMENTS IN OR RELATING TO THE PACKING OF DEBRIS IN MINES Brit. Pat. 1,502,284 (March 1, 1978). 7 pp. Brit Pat

Johnson, S. S., Denny, M. V., and Le Van, D. C., ANALYSES OF CLAY, SHALE AND RELATED MATERIALS--SOUTHWESTERN COUNTIES Virginia Department of Conservation and Economic Development, Division of Mineral Resources, in cooperation with U.S. Bureau of Mines, Mineral Resources Report 6 (1965). 210 pp. VaMRR

Jones, D. J. and Buller, E. L. (The Hudson Coal Company), NEW USES FOR ANTHRACITE COAL AND SLATE Industrial & Engineering Chemistry 27 (8), 953-954 (Aug. 27, 1935). CE338

Kempster, E. [to Thyssen (Great Britain) Limited], MINING U.S. Pat. 4,019,327 (Apr. 26, 1977). 5 pp. US Pat Removal of refuse from underground mines.

Kettle, R. J. and Williams, R. I. T. (University of Surrey, England), CEMENT STABILISED UNBURNT COLLIERY SHALE Roads and Road Construction 47, 200-206 (July 1969). CE349

Kettle, R. J. (1) and Williams, R. I. T. (2) [(1) University of Aston in Birmingham and (2) University of Surrey, England], FROST HEAVE AND HEAVING PRESSURE MEASUREMENTS IN COLLIERY SHALES Canadian Geotechnical J. 13 (2), 127-138 (May 1976). CE409

Kobeski, W. D., Srocki, S. W., Blosser, W. I., and Needham, J. J. (to United States Gypsum Company), METHOD OF TREATING EARTHEN AREAS U.S. Pat. 4,076,862 (Feb. 28, 1978). 8 pp. US Pat

Kost, L. A., Novikova, N. N., Sin'kova, L. A., and Shpirt, M. Ya., THE POSSIBILITY OF OBTAINING NITRIDE-CONTAINING MATERIALS FROM COAL WASTES Solid Fuel Chemistry (Khimiya Tverdogo Topliva) 11 (5), 27-29 (1977). Jour

Lawrence, J. A., SOME PROPERTIES OF SOUTH WALES COLLIERY DISCARDS Colliery Guardian 220 (6/7), 270-278, 329-333 (1972). Jour

Lindley, T., WHERE SHALL WE PUT THE COLLIERY WASTES? Surveyor 151 (4485), 13-16 (May 25, 1978). CE594

Longfellow, R. L. (Dravo Lime Co.), CHEMICAL STABILIZATION ENDS FINE COAL REFUSE PROBLEMS Coal Mining Process. 15 (1), 63-65 (Jan. 1978). Jour

Mackintosh, I. B., LAND RECLAMATION IN STOKE-ON-TRENT. PAPER ONE: SETTING THE SCENE Chartered Municipal Engineer 103 (10), 165-172 (Oct. 1976). CE335

MECHANISED PACKING FOR LONGWALL COAL FACES: FACE-END SYSTEMS AND PACKING EQUIPMENT Mine and Quarry 7 (1/2), 40, 43-44, 47 (Jan./Feb. 1978). Jour

Medvick, C. (1) and Grandt, A. F. (2) [(1) Illinois Department of Mines and Minerals, Land Reclamation Division and (2) Peabody Coal Company], LIME TREATMENT EXPERIMENTS--GOB REVEGETATION IN ILLINOIS in "Proceedings of the Illinois Mining Institute," Annual Meeting, Springfield, Illinois, Oct. 21-22, 1976. pp 48-62. 622. I29

Millbank, P., DERELICT SITE REJUVENATED FOR INDUSTRY Surveyor 149 (4419), 15 (Feb. 18, 1977). CE387

Miller, L. V. (Indiana Geological Survey), PRELIMINARY INVESTIGATION OF SLUDGE REFUSE FROM INDIANA COAL MINES Proceedings of the Indiana Academy of Science 81, 246-250 (1971). CE587

Minnick, L. J., Webster, W. C., and Smith, C. L. (to IU Conversion Systems, Inc.), METHOD OF TREATING COAL MINING REFUSE Brit. Pat. 1,436,507 (May 19, 1976). 6 pp. Brit Pat

Moulton, L. K. (1), Rao, S. K. (2), and Seals, R. K. (1) [(1) West Virginia University and (2) GAI Consultants], THE USE OF COAL ASSOCIATED WASTES IN THE CONSTRUCTION AND STABILIZATION OF REFUSE LANDFILLS in "New Horizons for Construction Materials," Vol. 1, H. Y. Fang, Ed., Lehigh Valley, Pennsylvania: Envo Publishing Company, Inc., 1976. pp 53-65. CE592

Murray, R. E. (North American Coal Corp.), ROCK REMOVAL METHODS IN COAL MINES Mining Congr. J. 58 (10), 57-61 (Oct. 1972). Jour

Nawrot, J. R., Pursell, P. L., Klimstra, W. D., and Jacobson, B. N., PROBLEM SITES: LANDS AFFECTED BY UNDERGROUND MINING FOR COAL IN ILLINOIS Southern Illinois University, Cooperative Wildlife Research Laboratory. Report to Illinois Institute for Environmental Quality, IIEQ Document No. 77/38 (Dec. 1977). 556 pp. CE583

O'Keefe, W., PLANT SYSTEM PROBLEMS: CAN WE EKE OUT PULVERIZED COAL WITH COAL-MINE WASHINGS? (Answers to July question) Power 121 (10), 134-135 (Oct. 1977). Jour

OPERATING IDEAS: ELECTRICITY SOLIDIFIES SLIME MINE WASTE Coal Age 82 (3), 109 (March 1977). Jour

Paone, J., Cox, R. H., and Allen, A. S. (U.S. Bureau of Mines, Washington, D.C.), SUBSIDENCE-CONTROL PROJECT IN THE BELLEVILLE-MARYVILLE AREA, ILLINOIS AIME-SME Fall Meeting and Exhibit, St. Louis, Missouri, 1977. Preprint No. 77-F-339. 22 pp. Also in Mining Engineering 30 (2), 183 (Feb. 1978). Jour

PEGWELL BAY HOVERPORT UTILISES UNBURNT COLLIERY SHALE Civil Engineering and Public Works Review 64, 606-607 (June 1969). CE334

PENNDOT: PUTTING COAL MINE WASTE TO GOOD USE Transportation Engineering 47, 57 (Nov. 1977). CE602

PLANT CLEANS BANK OR RUN-OF-MINE Coal Age 82 (9), 122-123, 126-127 (Sept. 1977). Jour

POLLUTION CONTROL GUIDELINES FOR COAL REFUSE PILES AND SLURRY PONDS W. A. Wahler and Associates, Interagency Energy-Environment Research and Development Program Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, EPA-600/7-78-222 (Nov. 1978). 214 pp. EPA

Price, H., TREATMENT APPLIED TO CONTROL A COLLIERY SPOIL HEAP FIRE The Colliery Guardian and J. of the Coal and Iron Trades 154 (3977), 533-535 (March 19, 1937). CE333

Proceedings Third Kentucky Coal Refuse Disposal and Utilization Seminar, Lexington, Kentucky, by University of Kentucky and Southeast Community College, May 11-12, 1977, Institute for Mining and Minerals Research, IMMR32-M4-77 (Dec. 1977). 119 pp. NTIS, PB-279 321/4WE. 631 K3

Killmeyer, R. P., Jr. (U.S. Bureau of Mines, Pittsburgh, PA), STATE-OF-THE-ART OF COAL CLEANING AND RECENT DEVELOPMENTS IN EQUIPMENT AND CIRCUITS pp 1-4.

Symonds, D. F. (Birtley Engineering Corp.), SOME ECONOMIC ASPECTS OF COAL PREPARATION pp 5-9.

West, T. W. (Dravo Corp.), PROBLEMS RELATED TO COAL PREPARATION PLANT DESIGN AND CONSTRUCTION pp 11-14.

Forster, H. W. (Passavant Corp.), PRESSURE FILTRATION TECHNOLOGY IN THE COAL INDUSTRY pp 15-18.

Keller, D. V., Jr. (Otisca Industries, Ltd.), GOB PILE AND SLURRY POND SEDIMENT BENEFICIATION USING THE OTISCA PROCESS pp 23-28.

Maneval, D. R. (Appalachian Regional Commission), PROCESSING OF COAL REFUSE FOR A SECOND YIELD OF STEAM COAL pp 31-39.

Gay, L. T. and Batchelder, S., Mrs. (Coal Purification Associates of Kentucky, Inc.), PROCESSING PLANT FOR THE RECLAMATION OF COAL pp 41-42.

Cannon, W. C. (MESA, Barbourville, KY), OVERVIEW OF MESA REGULATIONS FOR REFUSE PILES AND RETAINING DAMS pp 43-45.

Hammond, J. D. (Georgia Lightweight Aggregate Co.), LIGHTWEIGHT AGGREGATE AS A CONSTRUCTION MATERIAL pp 51-53.

Berger, T. R. (Lightweight Aggregate Producers Association), THE SINTERED LIGHTWEIGHT AGGREGATE INDUSTRY pp 55-58.

Rose, J. G. (University of Kentucky), SINTERED COAL REFUSE AS A CONSTRUCTION AGGREGATE pp 59-63.

Buxton, J. W., Knavel, D. E., and Yost, G. (University of Kentucky), SINTERED COAL REFUSE AS A GROWING MEDIUM FOR PLANTS pp 65-67.

Gilliam, D. R. (Appalachian Regional Commission), ENTERPRISE DEVELOPMENT: A FINANCIAL RESOURCE AND THE KENTUCKY ARC PROGRAM pp 69-70.

Hudson, L. K. (Alcoa Technical Center), ALUMINUM FROM COAL WASTES? pp 79-82.

Proceedings Third Kentucky Coal Refuse Disposal and Utilization Seminar (continued)

Burnet, G., Murtha, M. J., and Wijatno, H. (Iowa State University), RECOVERY OF ALUMINA FROM FLY ASH BY HIGH-TEMPERATURE CHLORINATION pp 83-88.

Katell, S. (West Virginia University), THE POTENTIAL ECONOMICS OF THE RECOVERY OF TRACE ELEMENTS IN COAL REFUSE pp 89-95.

Robl, T. L. and Bland, A. E. (University of Kentucky), THE DISTRIBUTION OF ALUMINUM IN SHALES ASSOCIATED WITH THE MAJOR ECONOMIC COAL SEAMS OF EASTERN KENTUCKY pp 97-101.

Winer, A. A. (Canada Department of Energy, Mines and Resources), SOURCES OF CANADIAN NON-BAUXITE ALUMINA pp 103-106.

PROCESSOR USES GERMAN PREP PLANTS Coal Age 83 (4), 99-102 (April 1978). Jour

Pulford, I. D. and Duncan, H. J. (Glasgow University), PREDICTING THE POTENTIAL ACIDITY IN RECLAIMED COAL MINE WASTE Surveyor 145 (4312), 36-37 (Jan. 31, 1975). R1012

Ramsauer, G., RECREATIONAL USE OF ANTHRACITE WASTELAND IN NORTHEASTERN PENNSYLVANIA; SUGGESTIONS FOR AN EVALUATION AND PLANNING PROCESS Economic Development Council of Northeastern Pennsylvania, in cooperation with U.S. Department of Agriculture, Northeastern Forest Experiment Station, Sept. 1977. 112 pp.+ Available, Economic Development Council of Northeastern Pennsylvania, P.O. Box 777, Avoca, Pennsylvania, 18641, and NTIS, FS-NE-4201. CE608

Roberts, J. M. (Ackenheil & Associates Geo Systems, Inc.), COST ANALYSIS OF TRANSPORTATION SYSTEMS FOR COAL REFUSE DISPOSAL Mining Congr. J. 64 (7), 53-58 (July 1978). Jour

Roessler, M. L. (Vibranetics Inc.), HANDLING PREP PLANT REFUSE WITH VIBRATING EQUIPMENT Coal Mining Process. 15 (9), 100-102, 104 (Sept. 1978) Jour

Roth, L. H., Cesare, J. A., and Allison, G. S., RAPID MONITORING OF COAL REFUSE EMBANKMENTS CH2M Hill, Report to U.S. Bureau of Mines, Office of Assistant Director--Mining, BuMines OFR 11-78 (June 1977). 110 pp. NTIS, PB-277 975 CE5

Sawyer, S. G., Mazzei, D. S., and Wu, K. K. (Technical Support Center, Pittsburgh, Pa.), COMPUTERIZED SLOPE STABILITY ANALYSIS OF REFUSE PILES AND IMPOUNDMENTS BY THE SIMPLIFIED BISHOP METHOD U.S. Department of the Interior, Mining Enforcement and Safety Administration, Informational Report 1068 (1978). 87 pp. MESA

Singh, B. K. and Erdmann, W., DEWATERING TAILINGS WITH A CONTINUOUS BELT PRESS Glückauf + Translation 114 (7), 169-170 (April 6, 1978). Jour

Snyder, G. A. (1), Zuhl, F. A. (1), and Burch, E. F. (2) [(1) Dravo Lime Co. and (2) Island Creek Coal Co.], SOLIDIFICATION OF FINE COAL REFUSE Mining Congr. J. 63 (12), 43-46 (Dec. 1977). Jour

Soderberg, R. L. and Corson, D. R., SUPPORT CAPABILITIES OF PNEUMATICALLY STOWED MATERIALS U.S. Bureau of Mines, RI 8202 (1976). 48 pp. BurM

Sopper, W. E., Kardos, L. T., and DiLissio, L. E., RECLAMATION OF ANTHRACITE COAL REFUSE USING TREATED MUNICIPAL WASTEWATER AND SLUDGE The Pennsylvania State University, Institute for Research on Land and Water Resources, Research Publication 94 (Dec. 1976). 95 pp. CE605

Sopper, W. E., Kardos, L. T., and Kerr, S. N., REVEGETATION OF ANTHRACITE REFUSE BANKS TREATED WITH MUNICIPAL SEWAGE EFFLUENT AND SLUDGE: PHASE II The Pennsylvania State University, Institute for Research on Land and Water Resources, Research Project Technical Completion Report to U.S. Bureau of Mines, Project Number: G0166049, March 1978. 80 pp. NTIS, PB-283 394/5WN. CE597

Sprute, R. H. and Kelsh, D. J., DEWATERING AND DENSIFICATION OF COAL WASTE BY DIRECT CURRENT--LABORATORY TESTS U.S. Bureau of Mines, RI 8197 (1976). 68 pp. BurM

Stearn, E. W., SOLID MINERAL WASTES--BLIGHT OR BONANZA? Rock Products 73 (6), 78-79, 96 (June 1970). CE585

Steinman, H. E. (Jones & Laughlin Steel Corporation), COAL REFUSE DISPOSAL IN PENNSYLVANIA American Mining Congress Coal Convention, Pittsburgh, Pa., May 6-9, 1973. 14 pp. 662.6 A665

Sukthumrong, A., THE ROLE OF EARTH COVER DEPTHS AND UPWARD ACID DIFFUSION ON THE SURVIVAL AND DISTRIBUTION OF VEGETATION ON COAL REFUSE PILES Ph.D. Thesis, University of Illinois at Urbana-Champaign, 1975. 126 pp. 631. S94

SURVEY OF MINING REFUSE USES IN NORTHEASTERN PENNSYLVANIA The Urban Services Group, Inc., Washington, D.C., Draft Final Report to The Economic Development Council of Northeastern Pennsylvania, Dec. 20, 1976. (50 pp). CE260

Thomson, G. M. (1) and Rodin, S. (2) [(1) National Coal Board, U.K. and (2) Wimpey Laboratories Ltd.], COLLIERY SPOIL TIPS--AFTER ABERFAN The Institution Civil Engineers, London, ICE Paper 7522 (1972). 60 pp. Discussion of the paper, Proceedings Institution of Civil Engineers 55, 677-712 (Sept. 1973). CE603

Toubeau, G., MANUFACTURE OF LIGHTWEIGHT AGGREGATES FROM WASHERY SCREEN DISCARD Sixth International Coal Preparation Congress Symp., Paris, France, 1973. (12 pp). CE53

Turner, C. W. (National Coal Board, South Yorkshire Area), THE PREVENTION AND UNDERGROUND DISPOSAL OF EXTRANEOUS DIRT The Mining Engineer 137 (197), 195-203 (Nov. 1977). Jour

UTILISATION OF COLLIERY SPOIL IN CIVIL ENGINEERING APPLICATIONS National Coal Board, London, Contract No. 6220-73/8/805, Commission of the European Communities, coal research reports, EUR 5736 e (1977). (41 pp). CE584

Voss, K. H. and Sielaff, H. D., FULLY-MECHANISED WINNING WITH SOLID STOWING IN THICK SEAMS AT NORDSTERN COLLIERY Glückauf + Translation 113 (19), 2-5 (Oct. 6, 1977). CE601

Wenger, M. E. and Schmidt, G. H., ANTHRACITE REFUSE AS AN AGGREGATE IN BITUMINOUS CONCRETE Pennsylvania Department of Highways, Bureau of Materials, Testing & Research, Bituminous Section, Research Project No. 70-8, June 1970. (22 pp). Also, Mellott, D. B., ANTHRACITE REFUSE IN ID-2A BITUMINOUS CONCRETE Pennsylvania Department of Transportation, Bureau of Materials, Testing and Research, Research Project No. 70-8, Final Report, March 1977. 7 pp. CE401

Wewerka, E. M. and Williams, J. M., TRACE ELEMENT CHARACTERIZATION OF COAL WASTES--FIRST ANNUAL REPORT, JULY 1, 1975 TO JUNE 30, 1976 Los Alamos Scientific Laboratory, Interagency Energy-Environment Research and Development Program Report to U.S. EPA, Office of Research and Development, and U.S. DOE, Division of Environmental Control Technology, EPA-600/7-78-028, LA-6835-PR (March 1978). 52 pp. DOE

Wewerka, E. M., Williams, J. M., Vanderborgh, N. E., Harmon, A. W., Wagner, P., Wanek, P. L., and Olsen, J. D., TRACE ELEMENT CHARACTERIZATION OF COAL WASTES - SECOND ANNUAL PROGRESS REPORT, OCTOBER 1, 1976 - SEPTEMBER 30, 1977 Los Alamos Scientific Laboratory, Interagency Energy-Environment Research and Development Program Report to U.S. EPA, Office of Research and Development, and U.S. DOE, Division of Environmental Control Technology, EPA-600/7-78-028a, LA-7360-PR (July 1978). 144 pp. EPA

Wewerka, E. M., Williams, J. M., and Wanek, P. L., (Los Alamos Scientific Laboratory), ASSESSMENT AND CONTROL OF ENVIRONMENTAL CONTAMINATION FROM TRACE ELEMENTS IN COAL PROCESSING WASTES in "Proceedings of National Conference on Health, Environmental Effects, and Control Technology of Energy Use," Washington, D.C., by U.S. EPA, Office of Energy, Minerals and Industry, Feb. 9-11, 1976. pp 226-229. 712.201 76-1; 628 U58h

Wewerka, E. M., Williams J. M., Wanek, P. L., and Olsen, J. D., ENVIRONMENTAL CONTAMINATION FROM TRACE ELEMENTS IN COAL PREPARATION WASTES: A LITERATURE REVIEW AND ASSESSMENT Los Alamos Scientific Laboratory, Interagency Energy-Environment Research and Development Program Report to U.S. EPA and U.S. ERDA, EPA-600/7-76-007, ERDA LA-6600-MS (Aug. 1976). 61 pp. EPA

Whaite, R. H., Allen, A. S., and Carlson, E. J., PUMPED-SLURRY BACKFILLING OF INACCESSIBLE MINE WORKINGS FOR SUBSIDENCE CONTROL: WITH AN APPENDIX ON HYDRAULIC MODEL STUDIES FOR BACKFILLING MINE CAVITIES U.S. Bureau of Mines, IC 8667 (1975). 83 pp.+ BurM

Williams, P. J. and Chadwick, M. J. (University of York, U.K.), SEASONAL VARIATION IN THE AVAILABILITY OF PLANT NUTRIENTS IN ACID COLLIERY SPOIL J. Applied Ecology 14 (3), 919-931 (1977). CE591

Wills, N. B. (Doncaster Metropolitan Institute of Higher Education, U.K.), THE PUMPED PACK SYSTEM AT MARKHAM MAIN COLLIERY Colliery Guardian 225 (12), 901-906 (Dec. 1977). Jour

Wilson, J. S. and Gillmore, D. W. (U.S. ERDA, Morgantown, W. Va.), PRELIMINARY REPORT ON FLUID-BED COMBUSTION OF ANTHRACITE WASTES in "Proceedings of the Fourth International Conference on Fluidized-Bed Combustion," McLean, Virginia, sponsored by U.S. Energy Research and Development Administration, coordinated by MITRE Corporation, Dec. 9-11, 1975. pp 55-67. 660 I64

Zellmer, S. D. and Carter, R. P. (Argonne National Laboratory), ABANDONED COAL MINE REFUSE AREAS: THEIR RECLAMATION AND USE American Society of Agricultural Engineers Winter Meeting, Chicago, Illinois, Dec. 13-16, 1977. Paper No. 77-2515. (18 pp). CE374

Zimmerman, R. E. (Paul Weir Company), PREPARATION HEADACHE: DISPOSAL OF REFUSE FINES World Coal 4 (4), 14 (April 1978). Jour